

Morphological studies on some Diffugiidae from Yugoslavia (Rhizopoda, Protozoa)

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Introduction

Recent studies (Ogden, 1979, 1980*a, b*, 1983; Ogden & Fairman, 1979) on the shell morphology of specimens belonging to the family Diffugiidae, have shown that detailed examination of these structures aid identification at the species level. It is now possible using the scanning electron microscope to demonstrate differences in shell structure and to examine more easily the type and arrangement of materials used in these complex constructions. Earlier workers were handicapped in similar examinations by the limited resolution of reflective optical microscopy. This made comparisons of shell structure difficult due to the different densities of the shell ranging from opaque to transparent, and sometimes the shape made a complete survey impracticable, ovoid or circular shells being particularly awkward. The present work is based on specimens collected in Serbia, Yugoslavia, from an area of peat bogs located on the high plateau at 1200 m, now submerged by the artificial lake 'Vlasina', which was formed by damming the river Vlasina and flooding a depression. A limnological study of this lake by Milovanović & Živković (1956) gives information relating to the chemical and biological conditions during the initial formation of this feature.

There are several reasons for our interest in the Diffugiidae of Yugoslavia, no previous records of testate amoebae are available for this region, there appears to be a similarity of this fauna with that reported from Africa by Gauthier-Lièvre & Thomas (1958) and specimens of the so-called 'cosmopolitan' species are available for comparison with those already described from the British Isles. Furthermore, the presence of several compressed species of *Diffugia* is unusual, as these forms appear to be rare.

Materials and methods

Samples were collected in September, 1947 from a pond 'Godžina bistrica' located at the

margin of a peat bog, and preserved in formalin. The samples were divided into two in 1980, one half was deposited in the Zoology Department, British Museum (Natural History) and the other was retained in Yugoslavia. This report is based mainly on the BM(NH) specimens but reference is also made to those in the other sample. Selected shells from the sample were washed in several changes of distilled water, then individuals were prepared for scanning electron microscopy using the technique described by Ogden (1979). The prepared stubs were examined using a Cambridge Stereoscan S180 operating at 10 kV and the results recorded on Ilford HP5 film.

Systematic descriptions

The species of *Diffugia* are listed in alphabetical order, except for the new species which are described last and *D. gramen* which is described with *D. schurmanni* for comparative purposes. The single species of the genus *Cucurbitella* and two species of *Pontigulasia* are described after the species of *Diffugia*. The measurements for total body length includes aboral processes, unless otherwise stated, breadth and diameter of aperture are taken as the widest point, the latter is an internal measurement.

Genus *DIFFLUGIA* Leclerc, 1815

Diffugia acuminata Ehrenberg, 1838

A single specimen, 199 μm long, 85 μm in breadth, with an aperture diameter of 37 μm , was examined and seen to be identical to those already described (Ogden, 1979). Significantly the distinctive organic cement pattern of this species, a network in which each mesh is further divided by a smaller network, was present.

Diffugia acutissima Deflandre, 1931

DESCRIPTION. The shell is transparent, pyriform with the sides tapering evenly from about the mid-body region and terminating usually with a sharp point (Fig. 1a). It is composed mainly of flattish pieces of quartz to give a smooth surface, with organic cement sometimes seen as part of the shell matrix (Fig. 1c). The cement is usually in the form of a network about 400 nm in diameter with walls 200 nm thick, and each mesh is covered by a smooth membrane (Fig. 1d). The aperture is circular and surrounded by small to medium particles (Fig. 1b). One specimen had an oblique aperture and a misaligned aboral protuberance (Fig. 1e), the latter being only partially sealed (Fig. 1f), but was considered to agree with the general description of this species in all other respects.

MEASUREMENTS (in μm). Four specimens: body length 178–217, breadth, 80–107, diameter of aperture 47–51.

GEOGRAPHICAL DISTRIBUTION. Argentina (Dioni, 1970), Chad (Gauthier-Lièvre & Thomas, 1958), Congo (Chardez, 1964), Gold Coast, Morocco (Gauthier-Lièvre & Thomas, 1958), United States of America (Leidy, 1879), Venezuela (Deflandre, 1931).

REMARKS. This species was initially described by Deflandre (1931) who considered that it was distinct from *D. acuminata* and its varieties by the sharpness of the aboral extremity. It differs from *D. ventricosa*, also described by Deflandre (1926) from Venezuela, by having a much wider body and aperture. The general body dimensions are similar to those given for *D. distenda* by Ogden (1983), which was a variety of *D. acuminata* but this species is curved aborally to a small tubular horn. The problems of differentiating between species with aboral horns or spines are emphasized in two publications by Chardez (1961 & 1973), which show several figures supposedly pertaining to the same species. It is clear that concise specific

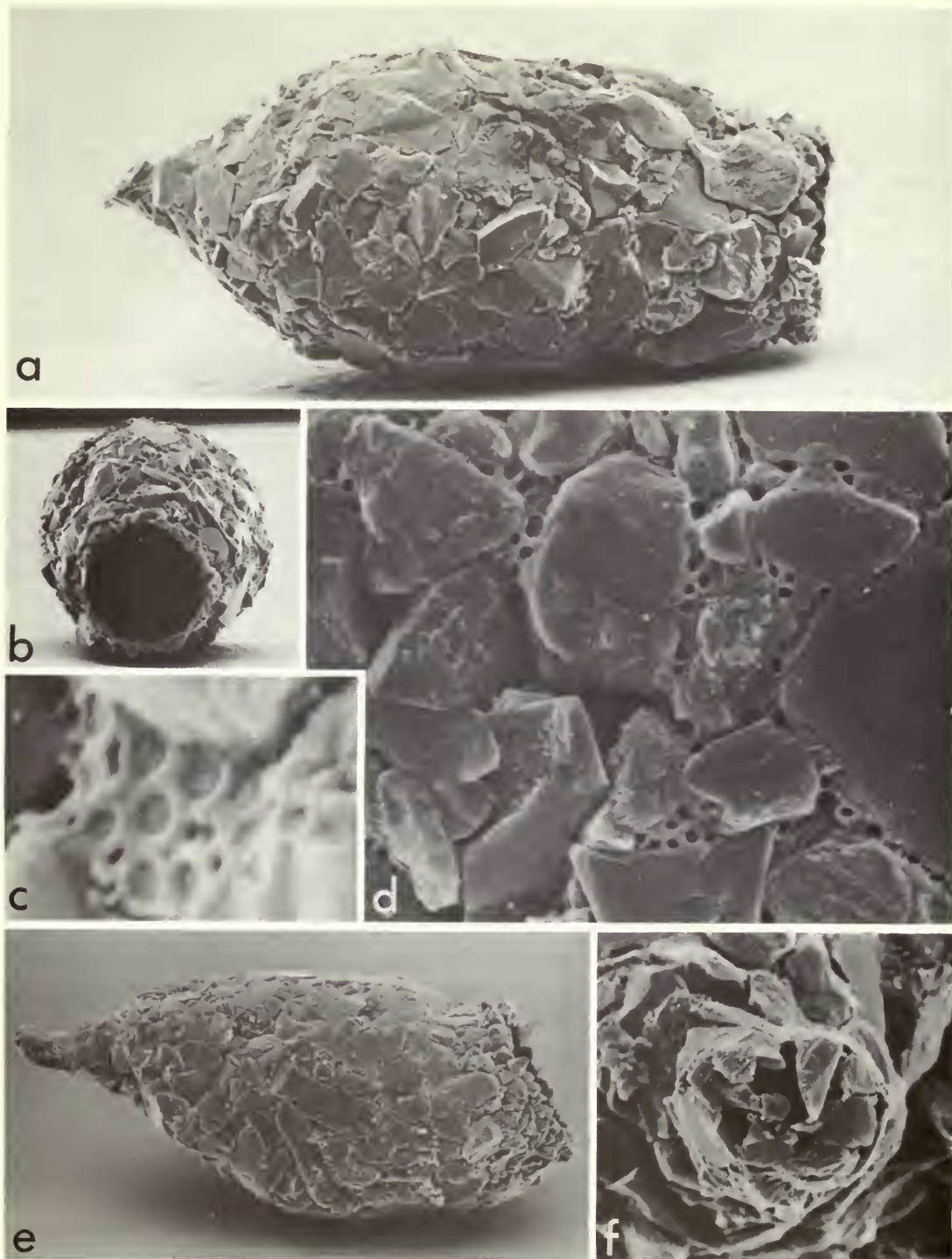


Fig. 1 *Diffflugia acutissima*: a, lateral view $\times 600$; b, apertural view $\times 360$; c, detail of organic cement pattern $\times 14000$; d, portion of shell surface to show organic cement between particles $\times 6600$; e, specimen with oblique aperture and non-central aboral spine $\times 420$; f, detail of partial closure at extremity of aboral spine $\times 1900$.

identification of specimens must await morphogenetic evidence of natural variation of this feature within a species.

Diffugia bicornis Penard, 1890

DESCRIPTION. The shell is transparent, ovoid or spherical with usually two, but occasionally one aboral spines (Figs 2a & b). Of the three specimens examined only one had a single long aboral spine. The surface is rough, thin and composed of a mixture of small to medium particles of quartz, with the occasional addition of either a portion of diatom frustule or a siliceous flagellate cyst. Each aboral spine is roughly pointed and composed of small particles. A network of organic cement is sometimes seen between particles (Fig. 2d). It is in the form of a sheet with each mesh being separated by small walls, about 80 nm thick. The mesh is irregular, about 300–400 nm in diameter, and each enclosure often has a small inner circular wall with arms connecting it to the mesh wall (Fig. 2e). The aperture is usually circular and surrounded by a mixture of particles (Fig. 2c).

MEASUREMENTS (μm). Three specimens: body length 75–85, breadth 39–53, diameter of aperture 19–23.

GEOGRAPHICAL DISTRIBUTION. Germany (Penard, 1890; Jung, 1936), Guatemala, Mexico (Laminger, 1973), Switzerland (Penard, 1902).

REMARKS. This species was initially described as a distinct species by Penard (1890) but was later considered (Penard, 1902) to be a small form of *D. elegans*, and he illustrated the variability of the shell in this form with several figures, including specimens with either one or two aboral spines. The specimens reported here have a fragile shell and are in good agreement with the original description of *D. bicornis*, the body lengths without the spines or horns being about 60 μm which is near to Penard's 50–60 μm . The contrast between these specimens and those of *D. elegans* studied recently (Ogden, 1979), which had robust shells and varied in body length between 113–158 μm , is marked. In the absence of information on other small forms identified as *D. elegans*, we have decided to use the earlier description of *D. bicornis* and consider the present specimens as a distinct species.

Diffugia bryophila (Penard, 1902)

A single specimen, 124 μm in body length, 53 μm broad with an aperture diameter of 17 μm . It was identical to those described by Ogden (1983).

Diffugia capreolata Penard, 1902

DESCRIPTION. The shell is opaque, thick, pyriform with a restriction of the neck at a position about one-third of the total body length, before it swells into the main body (Fig. 3a). It is composed of small to medium pieces of angular quartz, with small areas of organic cement as part of the matrix (Fig. 3c). This cement is in the form of a smooth sheet with irregular perforations (Fig. 3d), the reason that there is no apparent pattern to these perforations may be due to these areas being in thin strips rather than a more open arrangement. Each perforation has a mean diameter of 200 nm. The aperture is circular and surrounded by a regular distribution of medium particles (Fig. 3b).

MEASUREMENTS (in μm). One specimen: body length 225, breadth 128, diameter of aperture 58.

GEOGRAPHICAL DISTRIBUTION. Argentina (Dioni, 1970; Lena & Zaidenweg, 1975), Germany (Schönborn, 1965), Russia (Kourov, 1925), Tunisia (Gauthier-Lièvre & Thomas, 1958), Sudan (Gauthier-Lièvre & Thomas, 1958), Switzerland (Penard, 1902).

REMARKS. This species although it is large and has a distinctive outline, does not appear to be common and is rarely found in large numbers.

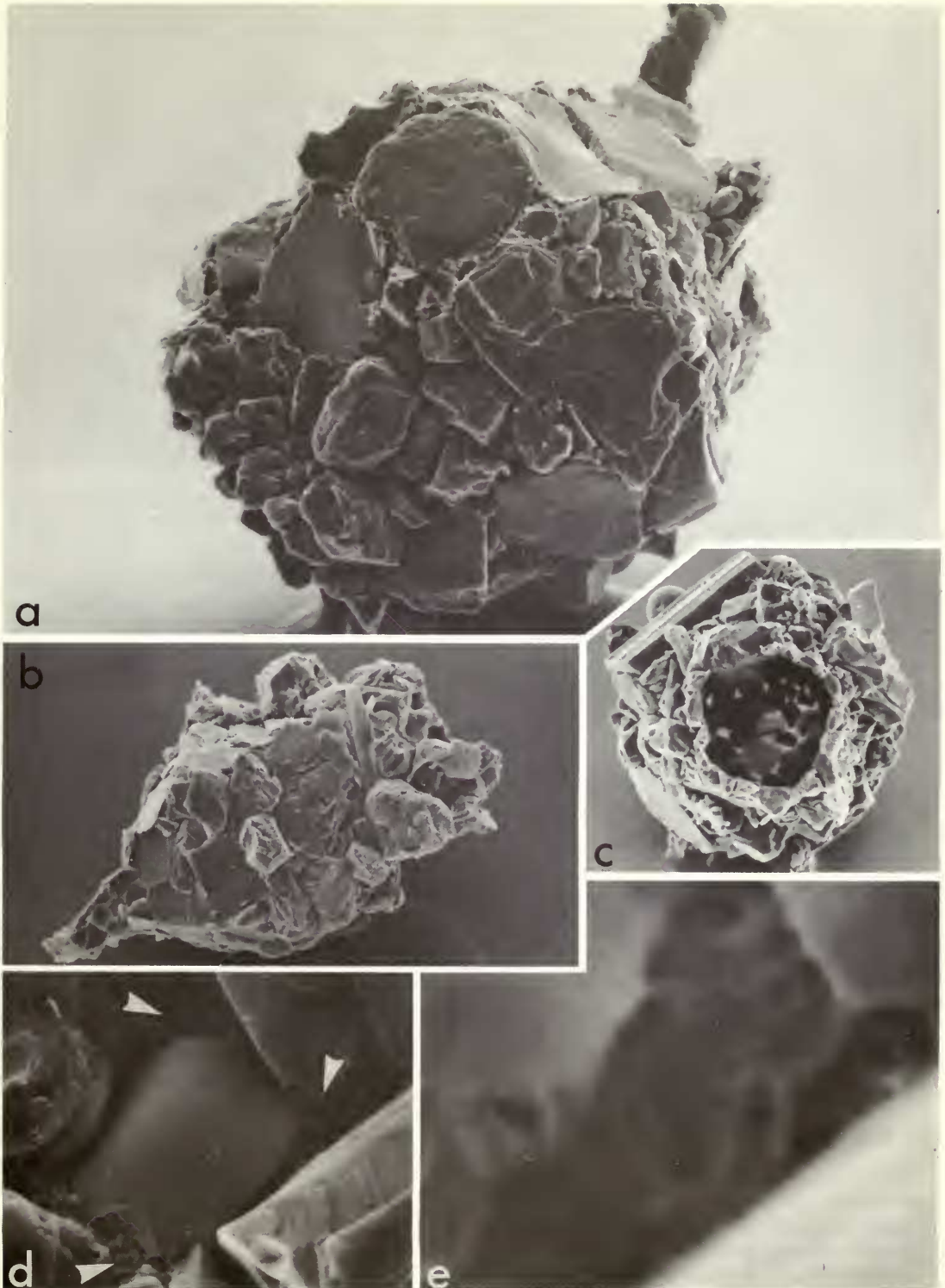


Fig. 2 *Diffflugia bicornis*: a, lateral view of specimen with two aboral spines $\times 1400$; b, lateral view of specimen with single aboral spine $\times 760$; c, apertural view $\times 820$; d, portion of shell surface to illustrate the organic cement (arrowed) $\times 7500$; e, detail of organic cement $\times 35000$.

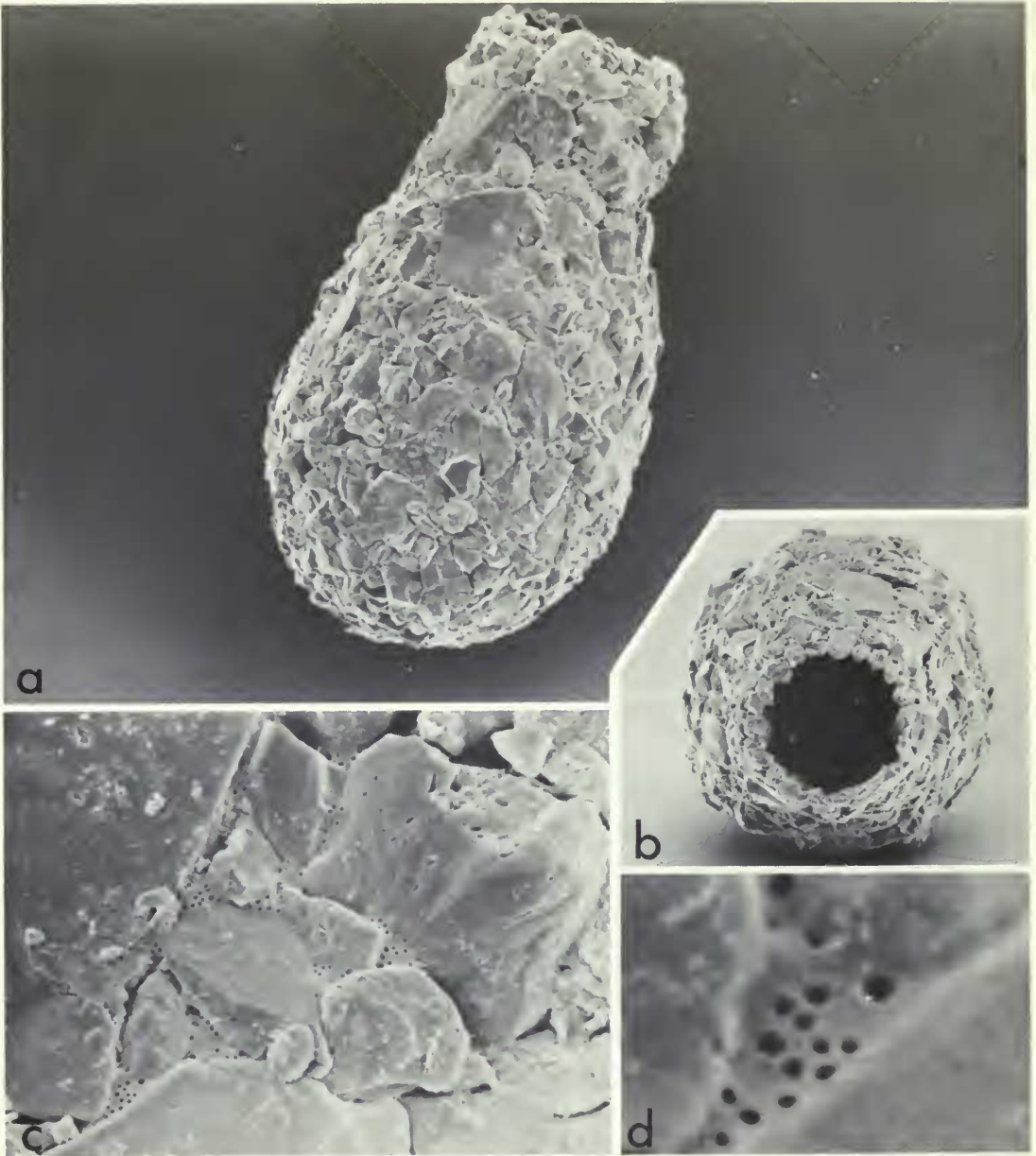


Fig. 3 *Diffflugia capreolata*: a, lateral view $\times 400$; b, apertural view $\times 340$; c, shell surface showing small areas of organic cement $\times 3000$; d, detail of organic cement pattern $\times 13000$.

Diffflugia corona Wallich, 1864

DESCRIPTION. The shell is brown, spherical or ovoid with distinct cone-like spines projecting from the aboral half of the body (Fig. 4a–d). The main body is composed of a mixture of small to medium particles of quartz arranged to give a relatively smooth shell. The spines are randomly arranged, varying between two and eight in number, made of small particles and are usually finely pointed. Organic cement in the form of a network is sometimes seen where particles meet. The aperture is circular and surrounded by a distinct denticular collar. There

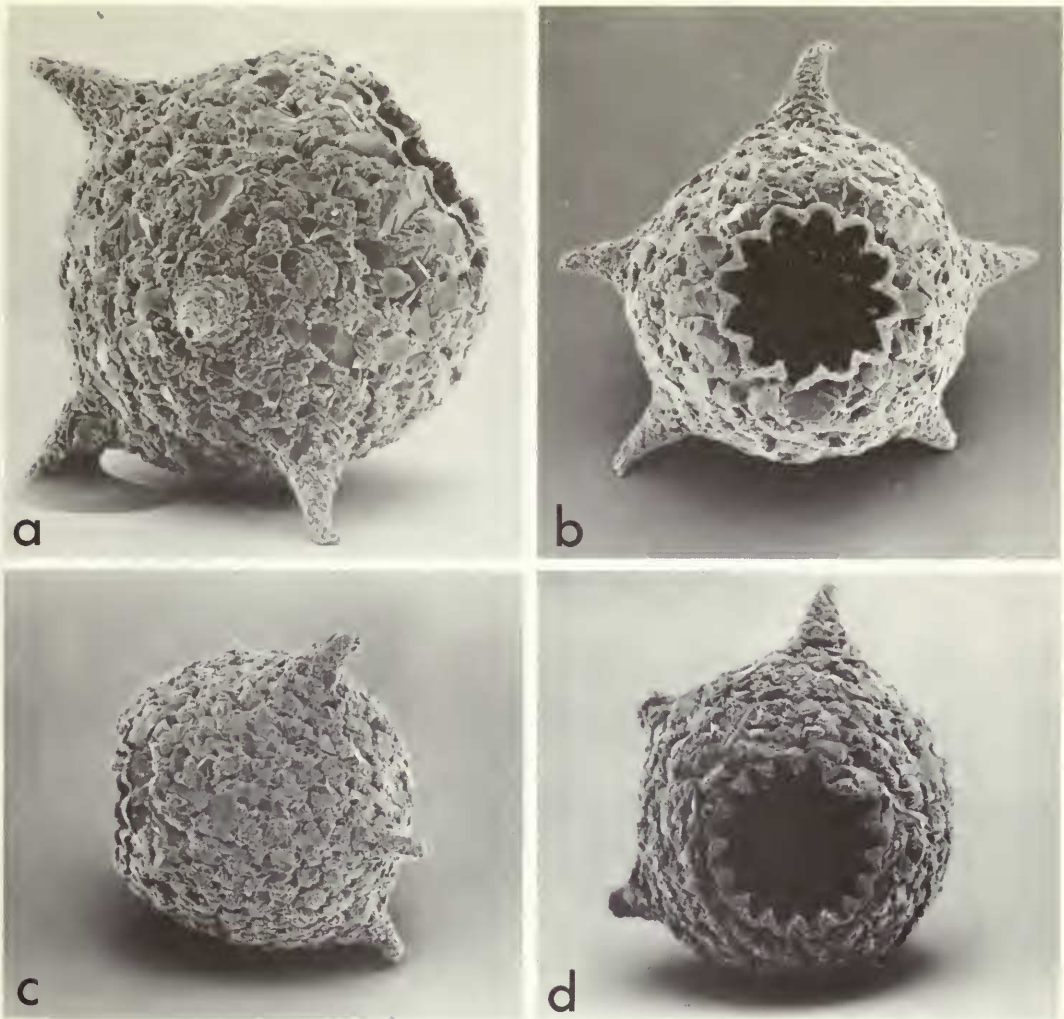


Fig. 4 *Diffflugia corona*: a, lateral view of specimen with six spines $\times 430$; b, apertural view of a, note the regular arrangement of twelve teeth $\times 330$; c, lateral view of another specimen $\times 240$; d, apertural view of c, to show sixteen thickened teeth $\times 240$.

are usually between ten to twelve tooth-like projections, although one specimen in the present sample had sixteen (Fig. 4d). They are arranged evenly, usually being finely pointed, but as seen in Fig. 4d compression of the teeth makes the projections thicker and the outer curvature of the collar more rounded.

MEASUREMENTS (in μm). Fourteen specimens: body length 126–190, breadth 126–177, diameter of aperture 53–86.

GEOGRAPHICAL DISTRIBUTION. Algeria (Gauthier-Lièvre & Thomas, 1958), Argentina (Boltovskoy & Lena, 1974; Lena & Ziadenweg, 1975; Vucetich, 1970), Austria (Laming, 1975), Belgium (Chardez, 1961, 1980), Brazil (Green, 1975), British Isles (Ogden & Hedley, 1980; Wallich, 1864), Chad (Gauthier-Lièvre & Thomas, 1958), Congo (Chardez, 1964; Gauthier-Lièvre & Thomas, 1958), Czechoslovakia (Ertl, 1965), Germany (Penard, 1890), Hungary (Berezky, 1973), India (Wallich, 1864), Java (Bartoš, 1963), Netherlands (Hoogenraad & Groot, 1940), Roumania (Godeanu *et al.*, 1973), Russia (Kourov, 1925),

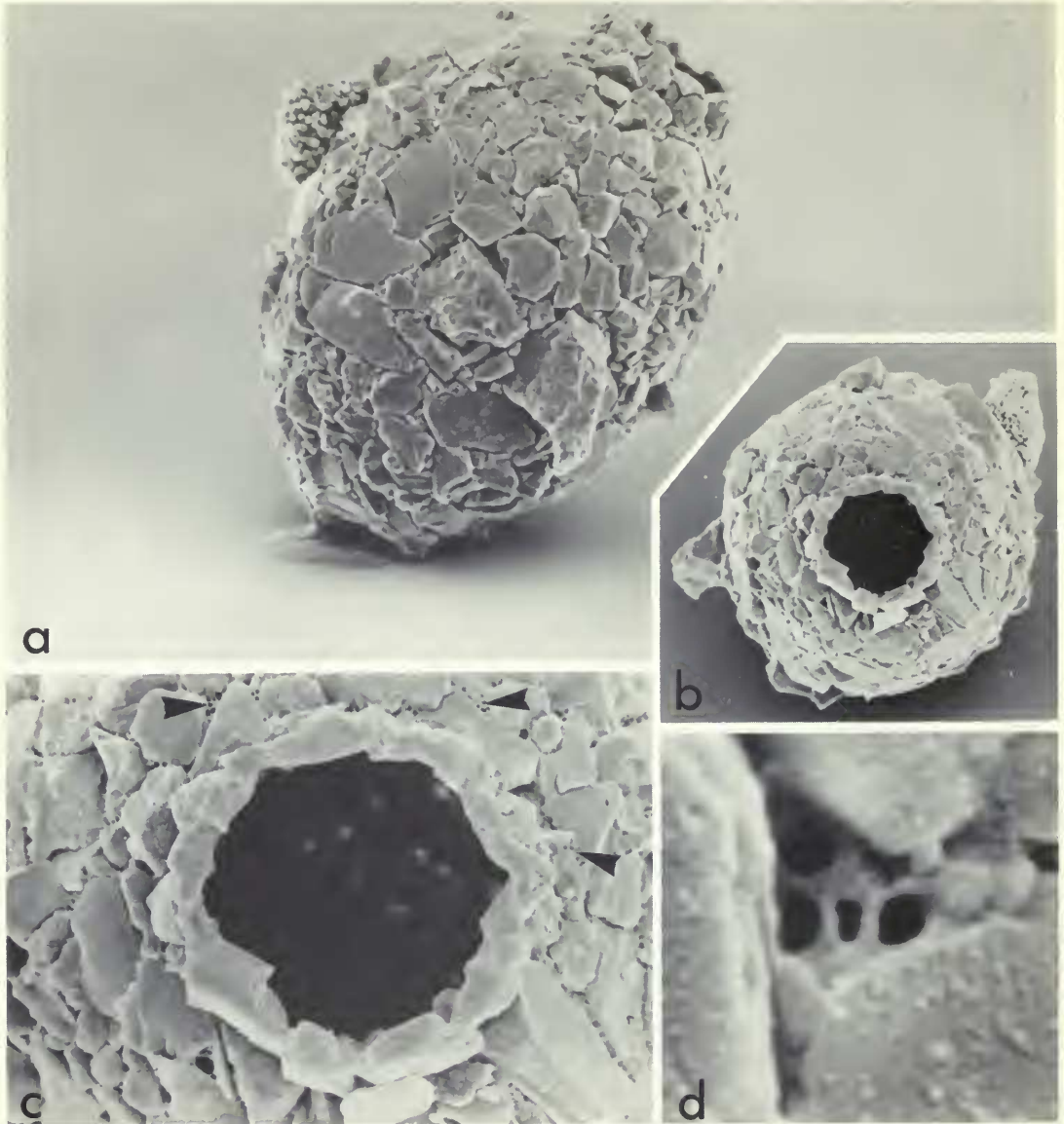


Fig. 5 *Diffflugia difficilis*: a, lateral view $\times 950$; apertural view $\times 760$; c, detail of aperture to show short collar and organic cement (arrowed) between particles $\times 2100$; d, detail of organic cement $\times 18000$.

Senegal, Sudan and West Africa (Gauthier-Lièvre & Thomas, 1958), South Africa (Oye, 1931), Switzerland (Penard, 1902), United States of America (Leidy, 1879).

REMARKS. This species is truly 'cosmopolitan' having been reported from most continents, but these sightings are probably due to the ease in observing the prominent features of this large, distinctive shell in any sample. Although Jennings (1916, 1937) showed that variation of both teeth and spines occurred under cultural conditions, subsequent authors have continued to designate forms and varieties based on these structures. It could be argued that Jennings's observations were made on rough cultures and that clonal cultures would behave differently, or that the medium used was limiting in some way. Nevertheless, some of the reported features could easily be considered to represent natural variation.

Difflugia decloitrei Godeanu, 1972

A single specimen similar to those recently described by Ogden (1983) was found. It is possibly an encysted form as the aperture was blocked with several flat pieces of quartz bound by organic cement.

MEASUREMENTS (in μm). One specimen: body length 79, breadth 52, diameter of aperture 22.

Difflugia difficilis Thomas, 1954

DESCRIPTION. The shell is transparent, ovoid, thin with a small apertural collar (Fig. 5a). It is composed of small to medium pieces of angular quartz arranged to make a relatively smooth surface, with the occasional projection of some particles. A network of organic cement is frequently seen as part of the shell matrix (Fig. 5c). The mesh of this network is open, each opening being about 350 nm wide with dividing walls 200 nm thick (Fig. 5d). A short collar made mainly of regularly arranged smallish particles, surrounds the circular aperture (Figs 5b & c).

MEASUREMENT (in μm). One specimen: body length 81, breadth 56, diameter of aperture 18.

GEOGRAPHICAL DISTRIBUTION. Algeria (Gauthier-Lièvre & Thomas, 1958), Argentina (Lena & Zaidenweg, 1975), Congo (Chardez, 1964), France (Thomas, 1954), Ivory Coast (Gauthier-Lièvre & Thomas, 1958), Roumania (Godeanu *et al.*, 1975), Sudan (Gauthier-Lièvre & Thomas, 1958).

REMARKS. This specimen has similar dimensions to those given for *D. difficilis* and *D. kabylica* by Gauthier-Lièvre & Thomas (1958). It differs from *D. kabylica* in having a smaller aperture which does not have a flattened irregular outline. It is most similar to *D. difficilis*, although it does not have 'une excoissance peu proéminente' as initially described by Thomas (1954). However this species was later reported (Gauthier-Lièvre & Thomas, 1958) to vary a great deal in body outline and often the aboral protuberance is absent. The feature that is characteristic of this species is the small collar and in the absence of further specimens the present specimen is considered to be *D. difficilis*.

Difflugia gramen

See p. 357.

Difflugia labiosa Wailes, 1919

Two specimens of this species identical to those recently redescribed by Ogden (1983) were found.

MEASUREMENTS (in μm). Two specimens: body length 176 & 177, breadth 111, diameter of aperture 45 & 52.

Difflugia lata Jung, 1942

Difflugia oblonga forma *lata* Jung, 1942

DESCRIPTION. The shell is opaque, pyriform having a rough surface composed of a mixture of mainly small to medium pieces of quartz, with an occasional large particle added (Fig. 6a). One specimen has a curved or malformed aboral extremity (Fig. 6c), but in all other respects is similar to the original description. Organic cement in the form of a network is seen as part of the shell matrix (Fig. 6d). The mesh of the network is open and has a mean diameter of 350 nm with walls 200 nm thick, although the walls often fuse to give larger areas of cement (Fig. 6e). The aperture is circular and surrounded by both small and medium particles arranged to give a somewhat irregular outline (Fig. 6b).

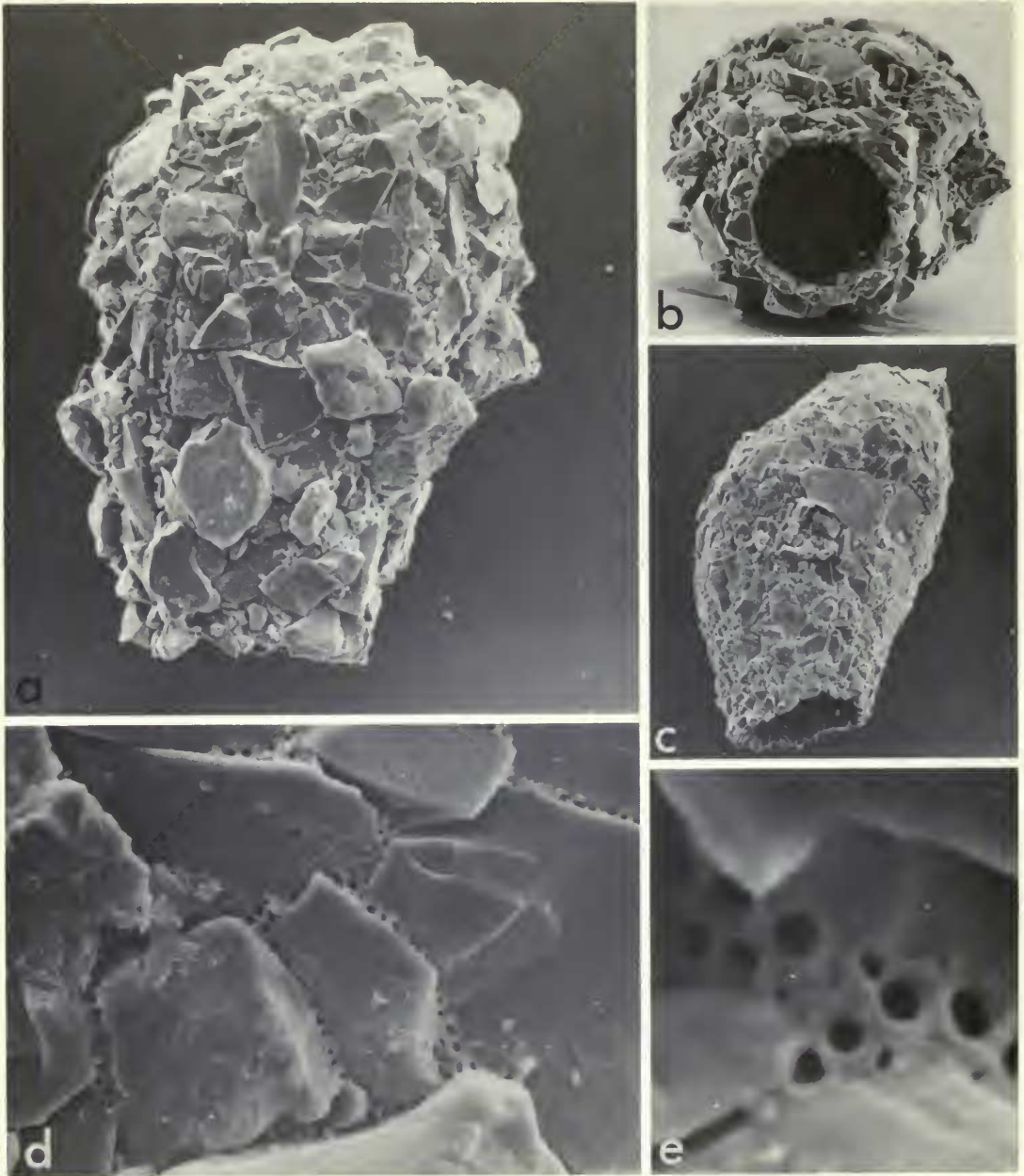


Fig. 6 *Diffflugia lata*: a, lateral view $\times 590$; b, apertural view $\times 420$; c, specimen with malformed aboral extremity $\times 400$; d, shell surface with organic cement as part of matrix $\times 3600$; e, detail of organic cement $\times 13500$.

MEASUREMENTS (in μm). Two specimens: body length 137 & 149, breadth 90 & 103, diameter of aperture 42 & 46.

GEOGRAPHICAL DISTRIBUTION. Chile (Jung, 1942).

REMARKS. This species is known apparently only from the initial description (Jung, 1942) as a new form of *D. oblonga*. Although measurements are not given in the original text, from

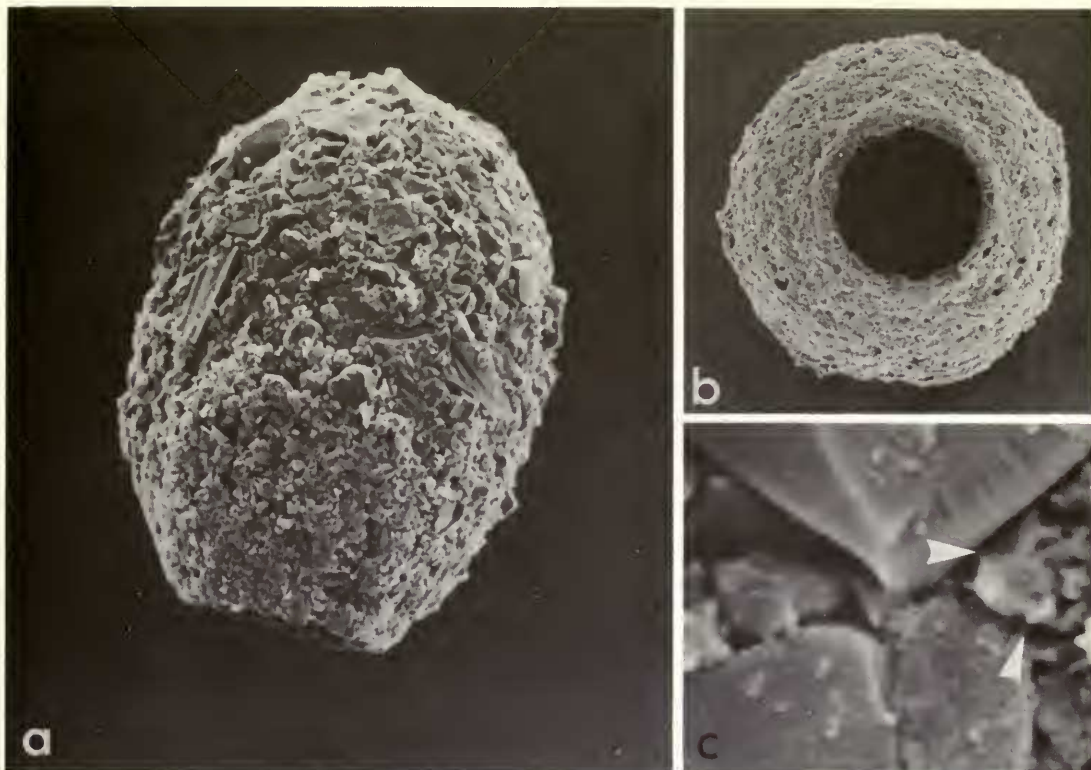


Fig. 7 *Diffugia levanderi*: a, lateral view $\times 730$; b, apertural view $\times 530$; c, portion of shell surface with organic cement (arrowed) $\times 7000$.

the figure these are estimated to be body length $157\ \mu\text{m}$, breadth $81\ \mu\text{m}$ and diameter of aperture $43\ \mu\text{m}$, which agree well with the present specimens. Note that our Fig. 6c compares well with that given by Jung (1942). This species is considered to be distinct from *D. oblonga* (see Ogden, 1979) in its stout pyriform body, wide aperture and organic cement pattern.

Diffugia levanderi Playfair, 1918

DESCRIPTION. The shell is ovoid or almost spherical, composed of flattish and angular pieces of quartz to give a regular outline (Fig. 7a). The particles appear to overlap and produce a robust structure with a network of organic cement, which is seen infrequently, binding the particles (Fig. 7c). Details of the surface are restricted because all the examined specimens have a slight covering of small debris, this latter material is clearly no part of the shell structure. The aperture is circular, well defined and surrounded by small particles (Fig. 7b).

MEASUREMENTS (in μm). Five specimens: body length 95–104, breadth 76–92, diameter of aperture 32–40.

GEOGRAPHICAL DISTRIBUTION. Algeria (Gauthier-Lièvre & Thomas, 1958), Australia (Playfair, 1918), Chile (Jung, 1942), Morocco and Tunisia (Gauthier-Lièvre & Thomas, 1958).

REMARKS. The descriptions of both Levander (1894) and Playfair (1918) refer to specimens having a similar shape but differing in size and composition. The larger being robust with a coarse appearance, whilst the smaller had a chitinous shell with a scattering of particles. Unable to differentiate them Playfair (1918) described them as a new species *D. levanderi*.

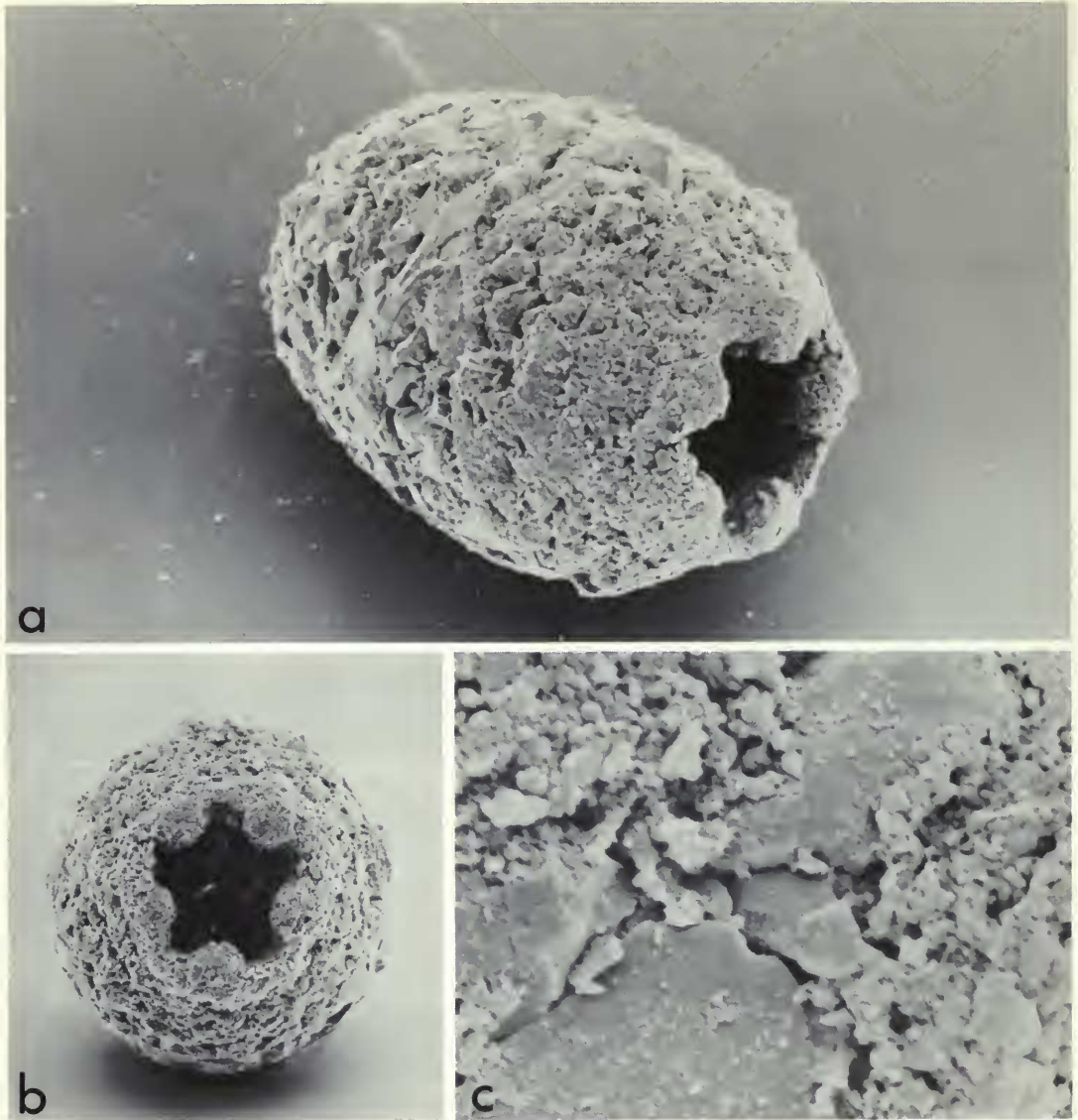


Fig. 8 *Diffflugia lismorensis*: a, latero-apertural view $\times 640$; b, apertural view to illustrate the thickened teeth and collar $\times 470$; c, part of shell surface with overlay of extraneous material $\times 3400$.

Fortunately, he created a precedence by initially describing the larger specimens, which are now considered to represent *D. levanderi*. Specimens similar to *D. levanderi* except for being smaller and having a thin shell whose particles did not overlap, were described by Godeanu (1972) as a new species *D. declotrei*, and these are considered to be identical to the smaller animals described by Levander (1894), Playfair (1918) and redescribed by Ogden (1983).

Diffflugia lismorensis Playfair, 1918

Diffflugia lismorensis var. *quinguelobata* Gauthier-Lièvre & Thomas, 1958
Diffflugia lismorensis var. *elongata* Gauthier-Lièvre & Thomas, 1958

DESCRIPTION. The shell is either elongate or ovoid, thick, composed of small to medium pieces of quartz arranged to give a rough surface (Fig. 8a). All the specimens examined had a proportion of the surface covered with an overlay of small extraneous material (Fig. 8c), nevertheless, the portions of actual surface visible had only strands of organic cement as part of the shell matrix. The aperture has five lobes which are equally spaced, strong, blunt, tooth-like extensions (Fig. 8b). Often the strengthening around these lobes, usually with small particles, gives it a collar-like appearance (Fig. 8b).

MEASUREMENTS (in μm). Three specimens: body length 132–144, breadth 96–104, diameter of aperture 36–45.

GEOGRAPHICAL DISTRIBUTION. Argentina (Vucetich, 1970), Australia (Playfair, 1918), Brazil (Green, 1973), Chad (Gauthier-Lièvre & Thomas, 1958), Congo (Chardez, 1964; Gauthier-Lièvre & Thomas, 1958), Gold Coast, Morocco and Sudan (Gauthier-Lièvre & Thomas, 1958).

REMARKS. Playfair (1918) described *D. lismorensis* as having an ovoid or sub-globular shell with a six-lobed aperture, and added two varieties *trilobulata* and *crucifera* which had three and four lobes respectively. Since that time two more varieties with five lobes, from Africa, have been described by Gauthier-Lièvre & Thomas (1958). They suggested the name *quinquelobata* for the ovoid variety and *elongata* for the specimens with an elongate body, the former has subsequently been reported again in Africa by Chardez (1964). Vucetich (1970) after examining about 50 specimens with seven lobes from Argentina, concluded that these were otherwise identical with *D. lismorensis* and she did not consider that differences in the number of lobes warranted specific designation. Until examples of this species from Australia, Africa and South America are compared, we agree with Vucetich (1970) that her specimens, plus those of Gauthier-Lièvre & Thomas are best described as *D. lismorensis*.

Diffugia lithophila (Penard, 1902), Gauthier-Lièvre & Thomas, 1958

Diffugia hydrostatica var. *lithophila* Penard, 1902

A single specimen identical to that described by Ogden & Hedley (1980) was examined. It is slightly smaller than previous records being 93 μm in body length, 67 μm breadth and having an apertural diameter of 32 μm ; however, it is proportionally similar. African specimens appear to have a larger range of body length, 100–170 μm (Gauthier-Lièvre & Thomas, 1958), to those from Europe 99–140 μm (Penard, 1902; Thomas, 1954).

Diffugia lucida Penard, 1890

A single specimen was examined, it measured 61 μm in body length, 39 μm broad, 19 μm depth with an aperture diameter of 22 μm . Although slightly smaller than those examined in an earlier study (Ogden, 1983) it was otherwise identical.

Diffugia manicata Penard, 1902

Two specimens 76 & 78 μm long, 39 & 43 μm in breadth, with aperture diameters of 14 & 17, were examined and found to be identical to those recently redescribed by Ogden (1983).

Diffugia mica Frenzel, 1892

DESCRIPTION. The shell is brownish, spherical or ovoid sometimes with a shallow apertural collar (Fig. 9a). It is composed of flattish pieces of quartz arranged to give a relatively smooth surface, although one specimen has most of the surface obscured by extraneous material. Organic cement is seen infrequently between particles but is more evident around the aperture. The cement around the aperture is apparent as a thin layer on the surface of some outer particles (Fig. 9c), but is a concentration of strands, some apparently fused, on the

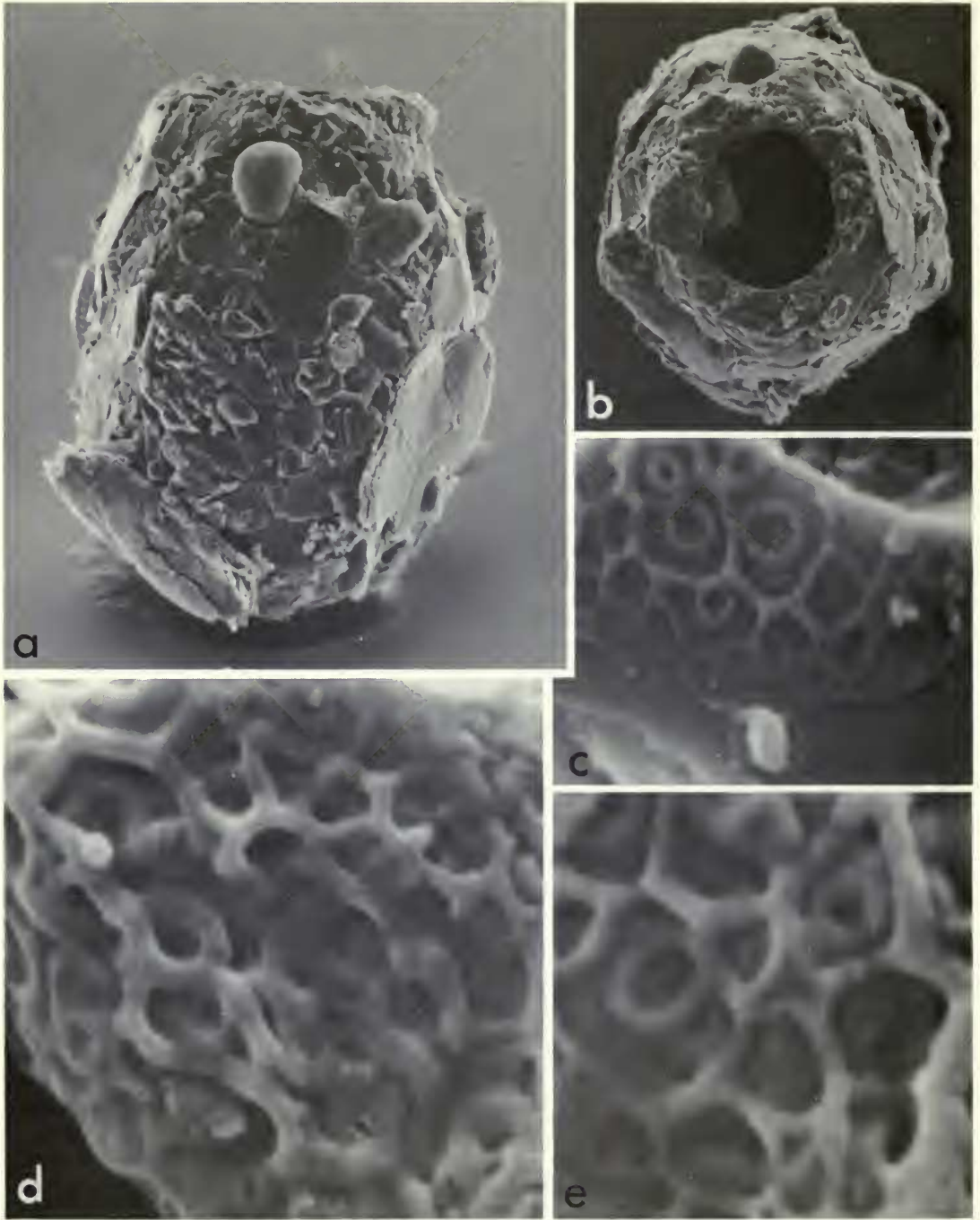


Fig. 9 *Diffugia mica*: a, lateral view showing the arrangement of flattish particles $\times 1400$; b, apertural view $\times 1100$; c, organic cement at outer limit of apertural concentration $\times 17000$; d, concentration of organic cement on apertural lip, note the fusion of some strands $\times 20000$; e, general appearance of organic cement network $\times 29000$.

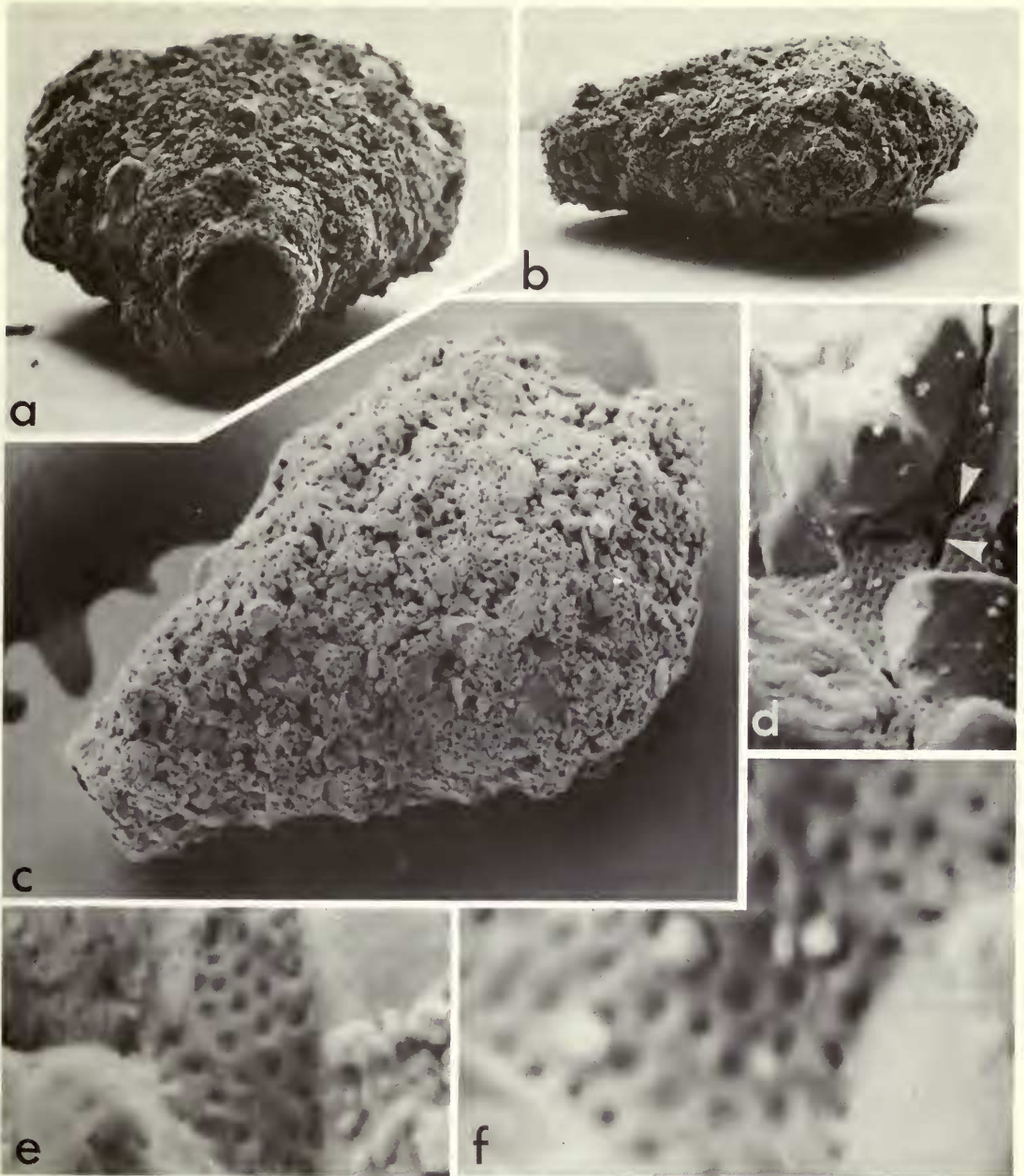


Fig. 10 *Diffflugia nodosa*: a, apertural view $\times 270$; b, view to illustrate lateral compression $\times 160$; c, lateral view showing the lateral wings and aboral protuberance $\times 970$; d, portion of shell surface close to aperture, note that the organic cement is torn (arrowed) $\times 4600$; e, & f, detail of organic cement pattern $\times 14000$ & $\times 21000$.

apertural lip (Fig. 9d). The general structure is of a network with an irregular mesh about 300 to 500 nm in diameter, with dividing walls about 100 nm thick (Fig. 9e). The aperture is circular, well defined, usually with an organic margin and sometimes with a collar (Fig. 9b).

MEASUREMENTS (in μm). Two specimens: body length 55 & 60, breadth 46 & 55, diameter of aperture 19 & 18.

REMARKS. These specimens are in good agreement with the description given by Ogden (1983). They are described again here to include information of the organic cement pattern.

Diffugia microclaviformis (Kourov, 1925)

The two specimens examined here fall within the range of body lengths given by Kourov (1925) of 139–160 μm , their respective measurements are:— body length 141 & 163 μm , breadth 66 & 75 μm and diameter of aperture 19 & 21 μm . Furthermore, they are in good agreement with the recent redescription of slightly larger specimens given by Ogden (1983).

Diffugia nodosa (Leidy, 1879) comb. nov.

Diffugia pyriformis var. *nodosa* Leidy, 1879 and in Penard, 1902

Diffugia oblonga var. *nodosa* Leidy, 1879 in Gauthier-Lièvre & Thomas, 1958

DESCRIPTION. The shell is thick, opaque, pyriform with the main body compressed to give two large lateral wings and an aboral extension or protuberance (Figs 10b & c). It is composed of a mixture of various sized pieces of quartz, which unfortunately in the present specimen is overlaid with debris. Nevertheless, some organic cement was observed close to the aperture (Fig. 10d); it is in the form of a network with the open mesh having a mean diameter of 200 nm and walls 200 nm thick (Figs 10e & f). The aperture is circular and surrounded by a regular arrangement of small particles (Fig. 10a).

MEASUREMENTS (in μm). One specimen: body length 367, breadth 241, depth 140, diameter of aperture 53.

GEOGRAPHICAL DISTRIBUTION. Algeria (Gauthier-Lièvre & Thomas, 1958), Belgium (Chardez, 1980; Chardez & Gaspar, 1976), Congo (Gauthier-Lièvre & Thomas, 1958), Germany (Laming, 1973; Schönborn, 1962), Ivory Coast (Gauthier-Lièvre & Thomas, 1958), Netherlands (Hoogenraad & Groot, 1940), Roumania (Godeanu *et al.*, 1973), Russia (Kourov, 1925), Sudan (Gauthier-Lièvre & Thomas, 1958), United States of America (Leidy, 1879).

REMARKS. This species has consistently been described as a variety of *D. oblonga*, initially Leidy (1879) remarked that it was a 'striking variety' distinguished by its unusually large size, compressed body and three conical eminences which varied a great deal in their development. Although Leidy (1879) reported it as being abundant on one particular occasion, so that one drop of ooze contained several dozen individuals, since that time no other reports have been so fruitful with specimens. Nevertheless, we consider that this variety is best treated as a distinct species which differs from the typical *D. oblonga* in the features described above and the organic cement pattern.

Diffugia oblonga Ehrenberg, 1838

Two specimens with the typically rough shell recently redescribed by Ogden & Fairman (1979) were examined; they measured: body length 232 & 263 μm , breadth 112 & 109 μm and diameter of aperture 46 & 41 μm .

Diffugia parva (Thomas, 1954)

The specimens of this species agree well with the redescription given by Ogden (1983) having a relatively smooth shell and areas of organic cement as part of the shell matrix; body length 143–203 μm , breadth 78–94 μm and diameter of aperture 24–32 μm .

Diffugia pristis Penard, 1902

Four specimens, body length 37–62 μm , breadth 27–38 μm and diameter of aperture 13–16 μm , having shells composed mainly of quartz particles but with some added diatom frustules, were examined.

Diffflugia pulex Penard, 1902

Two small ovoid specimens, body length 30 & 32 μm , breadth 22 & 24 μm with diameter of aperture 10 & 11 μm were examined.

Diffflugia rubescens Penard, 1891

Two specimens, body length 5 & 62 μm , breadth 34 & 40 μm and diameter of aperture 15 μm were examined.

Diffflugia gramen Penard, 1902

DESCRIPTION. The shell is transparent or light brown, spherical tapering towards the aperture (Fig. 11a). It is composed of a mixture of small to medium pieces of quartz, bound by an organic cement network (Fig. 11c). A ring of small pores surrounds the aperture (see Ogden, 1980b) which is trilobed and bordered by an irregular raised rim (Fig. 11b).

MEASUREMENTS (in μm). See Table 1.

REMARKS. A brief description of this species is included so that a direct comparison can be made with specimens of *Diffflugia schurmanni* Oye, 1932 described below.

Table 1 Range of measurements (in μm) of four ovoid species of *Diffflugia*.

| | n | | Length (L) | Breadth (B) | Diameter of aperture (da) | B/L | da/L | da/B |
|----------------------|----|-----|---------------|----------------|---------------------------------|-------------|-------------|-------------|
| <i>D. achlora</i> | 2 | (E) | 49–54 | 43–46 | 16–17 | | | |
| <i>D. schurmanni</i> | 20 | (Y) | 50–70 | 36–52 | 18–26 | 0.74 ± 0.05 | 0.35 ± 0.04 | 0.48 ± 0.03 |
| <i>D. gramen</i> | 24 | (Y) | 69–90 | 51–81 | 26–32 | 0.84 ± 0.08 | 0.36 ± 0.03 | 0.44 ± 0.04 |
| <i>D. gramen</i> | 35 | (E) | 89–117 | 70–112 | 23–39 | 0.96 ± 0.07 | 0.34 ± 0.04 | 0.36 ± 0.03 |
| <i>D. lobostoma</i> | 44 | (E) | 123–186 | 106–166 | 32–60 | 0.87 ± 0.06 | 0.29 ± 0.03 | 0.33 ± 0.02 |

n = number of specimens; E = Norfolk, England (see Ogden, 1980b); Y = Yugoslavia (present work)

Diffflugia schurmanni Oye, 1932

DESCRIPTION. The shell is transparent, elongate ovoid, tapering equally to the aperture and aboral extremity (Fig. 11d). It is composed mainly of flattish pieces of quartz arranged to give a smooth and rather fragile appearance. The particles are bound by organic cement, similar to that described for *D. gramen*, but because the particles fit closely together cement is not seen as frequently as in that species. The aperture is trilobed with the dividing projections less pronounced in apertural view (Fig. 11e) compared with those of *D. gramen*, and this gives it a more open outline especially as the shell has a smaller breadth (see Table 1). In addition, the surrounding ridge is often not as well defined although in lateral view the lobes are more prominent (Fig. 11d). A ring of small pores surrounds the aperture, similar to those described for *D. gramen* (see Ogden, 1980b).

MEASUREMENTS (in μm). See Table 1.

GEOGRAPHICAL DISTRIBUTION. Brazil (Green, 1975), Congo (Gauthier-Lièvre & Thomas, 1958), Guatemala (Laming, 1973a), Senegal (Gauthier-Lièvre & Thomas, 1958), South Africa (Oye, 1932), Sudan (Gauthier-Lièvre & Thomas, 1958).

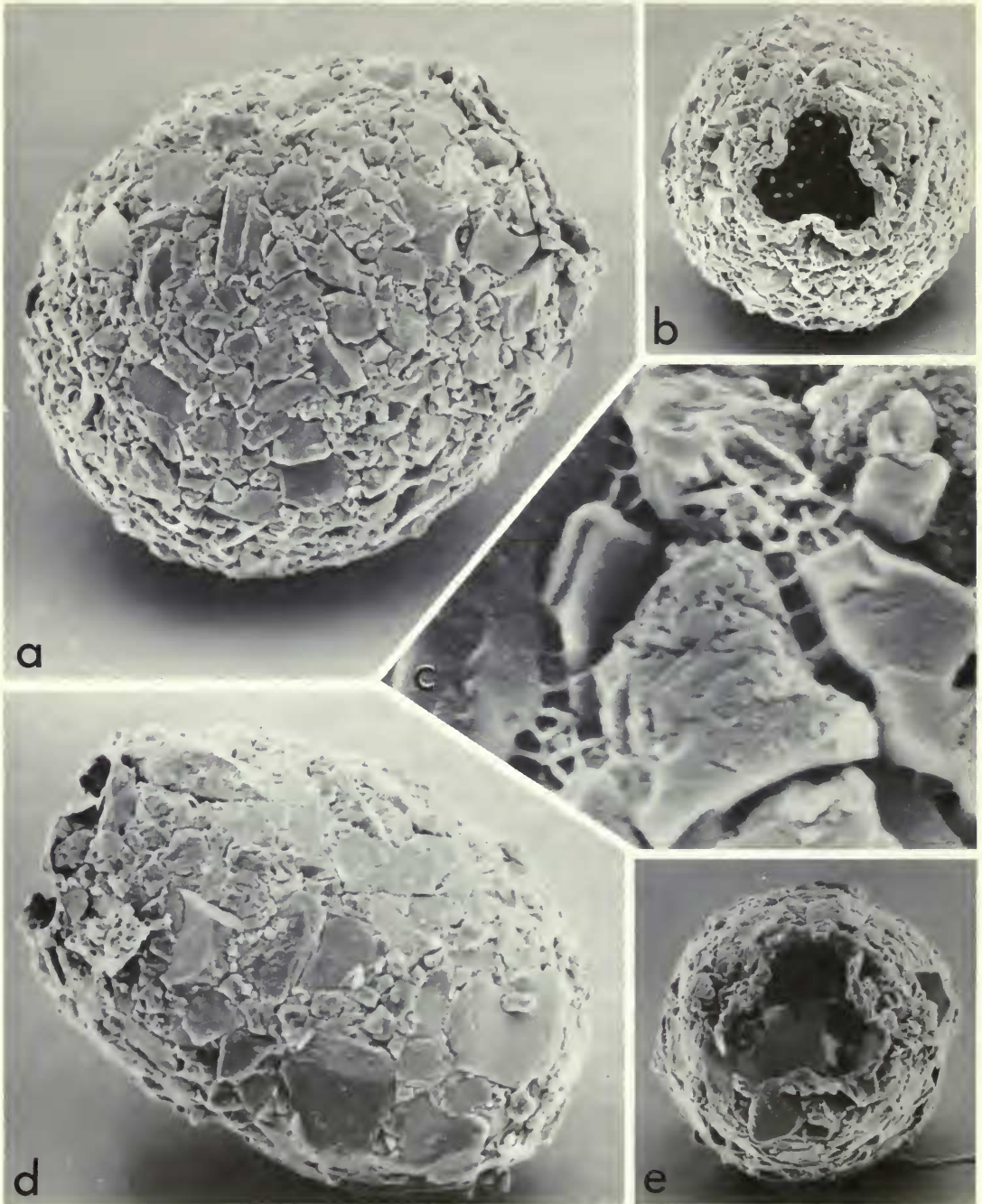


Fig. 11 *Diffflugia gramen*: a, lateral view $\times 1000$; b, apertural view, note the small aperture opening but well defined surrounding ridge $\times 610$; c, detail of organic cement pattern $\times 7500$ *Diffflugia schurmanni*; d, lateral view, note the different arrangement of particles and defined apertural lobes $\times 1500$; e, apertural view to illustrate wide opening and less pronounced ridge $\times 1000$.

REMARKS. Reports of this species appear to be confined to tropical countries, but this may be due to it being reported elsewhere as *D. gramen*. The measurements of specimens for the three similar species, *D. achlora*, *D. gramen* and *D. lobostoma*, redescribed recently (Ogden, 1980b) from England are listed in Table 1 for comparison. It would appear that the information given does not help to resolve specific identification, which still depends on the measurement of overall body length and differences in shell structure. The significance of these latter features must await morphological studies on clonal cultures.

D. schurmanni is considered to be distinct from *D. gramen* in being smaller, more elongate, having a smooth surface composed of flattish particles and a more open aperture.

Difflugia smilion Gauthier-Lièvre & Thomas, 1958

DESCRIPTION. Unfortunately the only specimen was broken during preparation. The shell is transparent, elongate with a distinct aboral conical protuberance. It is composed mainly of medium to large, angular or flat pieces of quartz to give a rough surface. Organic cement is seen at the junctions of these particles as enclosed spheres, or spheres with small openings, or as a thick rimmed circle with four equal openings (Fig. 12b & c). The spheres are about 600 nm in diameter, the walls of the circle are about 150 nm thick and the internal openings vary between 150–220 nm. The aperture is circular and surrounded mainly by medium sized particles (Fig. 12a).

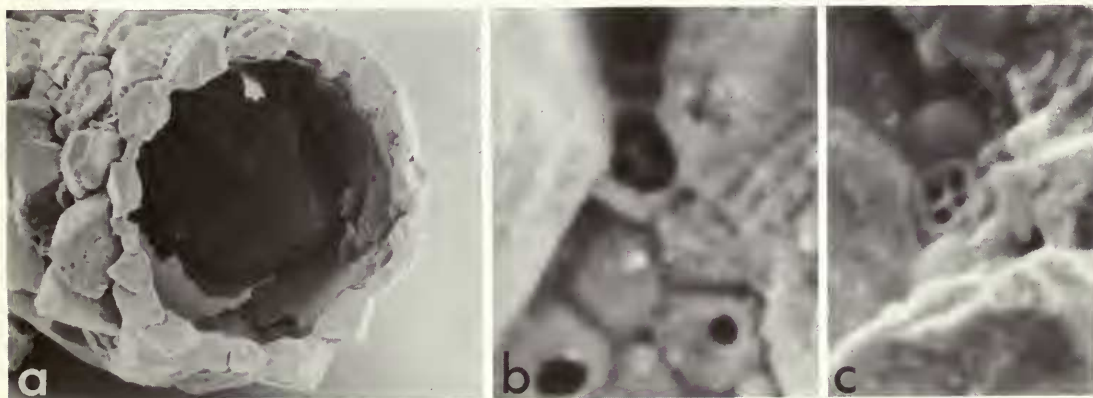


Fig. 12 *Difflugia smilion*: a, apertural view to show arrangement of surrounding particles; b & c, detail of organic cement pattern $\times 21000$ & $\times 13000$.

Table 2 Range of measurements (in μm) of *D. tuberculata* and *D. walesi*

| | n | | Length (L) | Breadth (B) | Diameter of aperture (da) | B/L | da/L | da/B |
|-----------------------|----|-----|---------------|----------------|------------------------------|-----------------|-----------------|-----------------|
| <i>D. walesi</i> (i) | 20 | (Y) | 84–111 | 63–103 | 27–40 | 0.85 ± 0.09 | 0.32 ± 0.03 | 0.38 ± 0.01 |
| <i>D. walesi</i> (ii) | 19 | (Y) | 73–103 | 62–82 | 22–28 | 0.83 ± 0.07 | 0.30 ± 0.03 | 0.36 ± 0.02 |
| <i>D. walesi</i> | 6 | (E) | 96–112 | 79–90 | 29–34 | 0.80 ± 0.03 | 0.30 ± 0.01 | 0.38 ± 0.02 |
| <i>D. tuberculata</i> | 6 | (Y) | 96–116 | 74–94 | 31–35 | 0.82 ± 0.05 | 0.31 ± 0.02 | 0.37 ± 0.03 |
| <i>D. tuberculata</i> | 27 | (E) | 102–152 | 88–141 | 29–44 | 0.89 ± 0.10 | 0.29 ± 0.04 | 0.33 ± 0.02 |

n = number of specimens; (i) = typical specimens with indented aperture; (ii) = specimens with circular aperture; E = Norfolk, England (see Ogden, 1980b); Y = Yugoslavia (present work)

GEOGRAPHICAL DISTRIBUTION. Algeria (Gauthier-Lièvre & Thomas, 1958), Argentina (Dioni, 1970), Belgium (Chardez, 1980; Chardez & Gaspar, 1976), Brazil (Green, 1975), Congo (Chardez, 1964), France (Thomas, 1953, 1954), Ivory Coast (Gauthier-Lièvre & Thomas, 1958), Poland (Moraczewski, 1965), Roumania (Godeanu *et al.*, 1973).

REMARKS. This specimen is similar in all respects to the description given by Thomas (1953), the body length being about the same, 226 μm , although here it is an estimated figure because of the state of the specimen. No value is given for the breadth, but it was seen to be only slightly larger than the aperture which has a diameter of 41 μm .

Difflugia tuberculata (Wallich, 1864)

Specimens with the typical protuberances were examined and the measurements are included in Table 2.

Difflugia walesi Ogden, 1980

Difflugia tuberculata var. *minor* Wailes, 1919

DESCRIPTION. Two distinct forms of this species are present in the examined material, both are figured and described.

In the typical form the shell is transparent, ovoid but tapering slightly near the aperture (Fig. 13a). It is composed mainly of flattish pieces of quartz and siliceous elements arranged to give a smooth surface (Fig. 13a). The aperture is polygonal with usually five but occasionally six indentations and bordered by a small lip (Fig. 13b). A ring of about ten small pores is often seen just posterior to the apertural rim.

In the other form the shell is ovoid but more markedly tapered towards the aperture (Fig. 13c). The aperture is circular with no indentations (Fig. 13d), but with a similar small ridge as in the typical form. There are nine or more small tooth-like projections inside the apertural rim on a level with the main body of the shell (Fig. 13e), these tooth-like structures are similar to those sometimes seen at the apex of each apertural projection in the polygonal aperture specimens.

MEASUREMENTS (in μm). See Table 2.

REMARKS. The similarity of dimensions between the present specimens and those reported recently from Norfolk, England, highlight the difficulty of differentiating the two species *D. tuberculata* and *D. walesi*. A further division of *D. walesi* is not desirable unless supported by strong morphological evidence, therefore, although the specimens are reported as two groups no particular significance is attached to these differences.

Difflugia balcanica sp. nov.

DESCRIPTION. The shell is transparent, ovoid or roughly circular with an aboral cone or spine and laterally compressed, the shape resembles either an arrow-head or a leaf (Figs 14a & c). It is composed of a mixture of small to large pieces of mainly flattish quartz, arranged to give a relatively smooth but irregular surface, unfortunately the illustrated specimen has some overlying debris scattered on the anterior third of the body. An open network of organic cement is seen between the particles. The aperture is roughly circular and surrounded by small or medium pieces of quartz (Fig. 14b).

MEASUREMENTS (in μm). Two specimens: body length 111–114, breadth 79–82, depth 50, diameter of aperture 31.

REMARKS. There does not appear to be any prior descriptions of any similar compressed species of *Difflugia*, and *D. balcanica* is considered to be distinct in having a leaf-like shape, with an angular surface and a pointed aboral extremity.

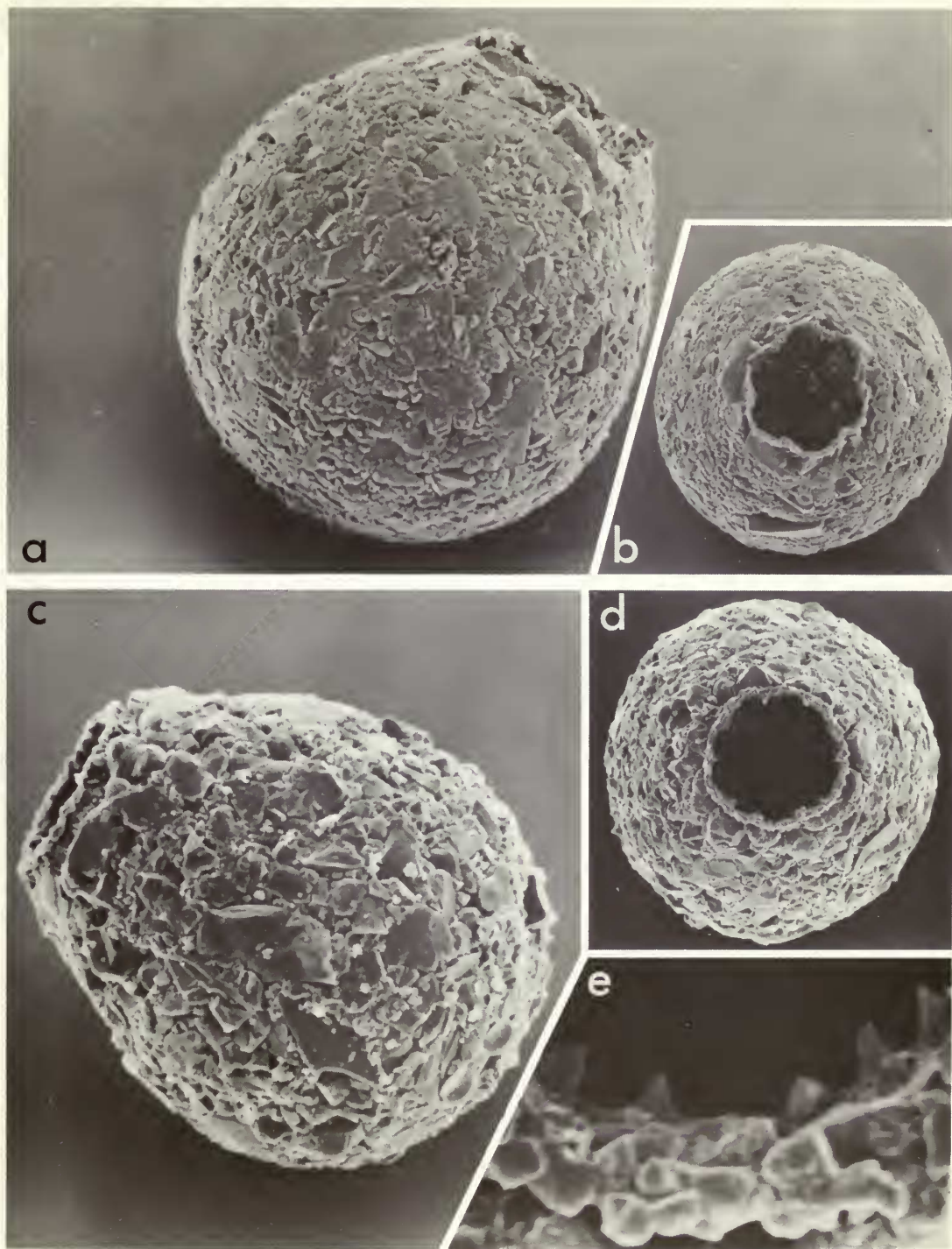


Fig. 13 *Diffflugia wailesi*: a, lateral view of typical specimen $\times 760$; b, apertural view of a, note the six indentations $\times 470$; c, lateral view of elongate specimen $\times 1100$; d, apertural view of c, to show circular aperture and surrounding collar $\times 720$; e, detail of teeth on inner rim of circular aperture $\times 5100$.

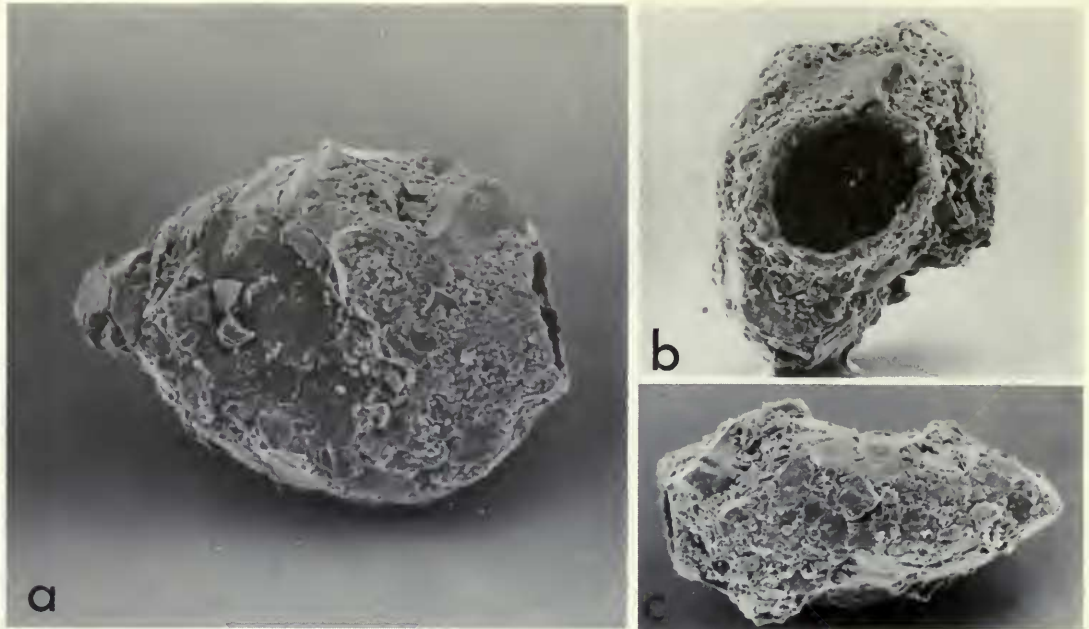


Fig. 14 *Difflugia balcanica* sp. nov.: a, view to illustrate general outline with aboral protuberance $\times 570$; b, apertural view $\times 620$; c, lateral view to show compression, note the tapering at the apertural and aboral extremities $\times 460$.

***Difflugia bistrica* sp. nov.**

DESCRIPTION. The shell is ovoid or roughly circular, thin and laterally compressed (Fig. 15a & b). It is composed of medium flattened pieces of quartz with smaller particles between to give a smooth surface (Fig. 15d). Small areas of organic cement occur infrequently, and are usually in the form of a network (Fig. 15e). The aperture is a regular oval and surrounded by small particles (Fig. 15c).

MEASUREMENTS (in μm). One specimen: body length 104, breadth 84, depth 54, diameter of aperture 38.

REMARKS. Although this specimen has an encrustation of small debris, which is not part of the shell matrix (see Fig. 15d), it is still possible to describe the surface as smooth. This species is similar to *D. balcanica* in dimensions and degree of compression, but differs significantly in having a rounded, smooth shell which is curved gently at the aboral extremity. Notwithstanding that this description is based on a single specimen, it is still considered to represent a distinct species and is so designated.

***Difflugia dragana* sp. nov.**

DESCRIPTION. The shell is opaque, elongate ovoid, thick, tapering gradually from the mid-body position to a gracefully curved aboral extremity and anteriorly to the suggestion of a small apertural collar, it is laterally compressed (Figs 16a & b). Medium pieces of quartz appear to make up most of the surface with smaller particles added. Only small strands of organic cement have been seen (Fig. 16d) between these particles. The aperture is circular and surrounded by mainly small particles of quartz (Fig. 16c).

MEASUREMENTS (in μm). One specimen: body length 195, breadth 119, depth 96, diameter of aperture 48.

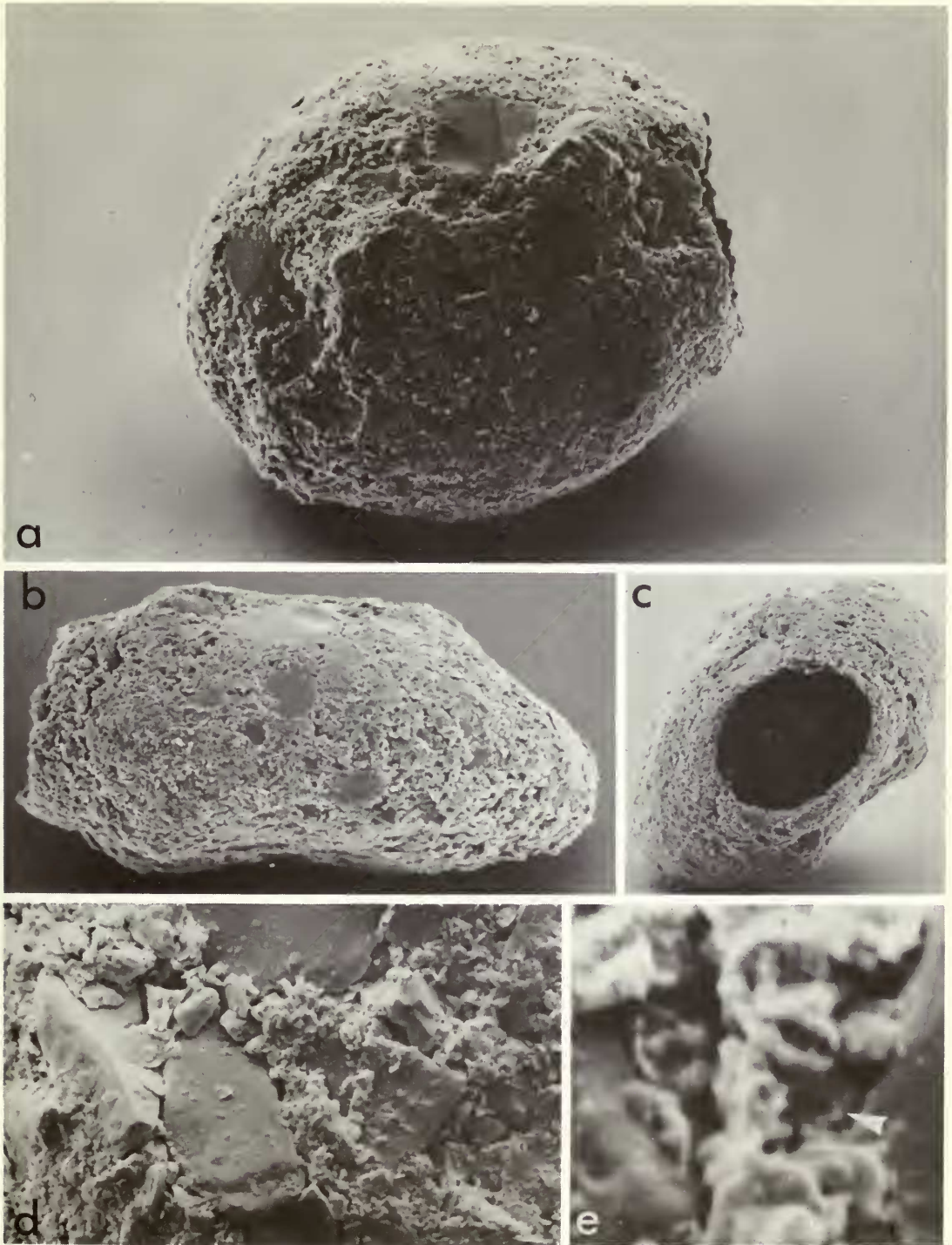


Fig. 15 *Diffugia bistrica* sp. nov.: a, lateral view to show regular, circular shape $\times 760$; b, view to illustrate lateral compression, note the gentle aboral curvature $\times 720$; c, apertural view showing oval-shaped aperture $\times 660$; d, portion of shell surface to show flat particles overlaid with extraneous debris $\times 2900$; e, organic cement (arrowed) partially obscured by debris $\times 13000$.

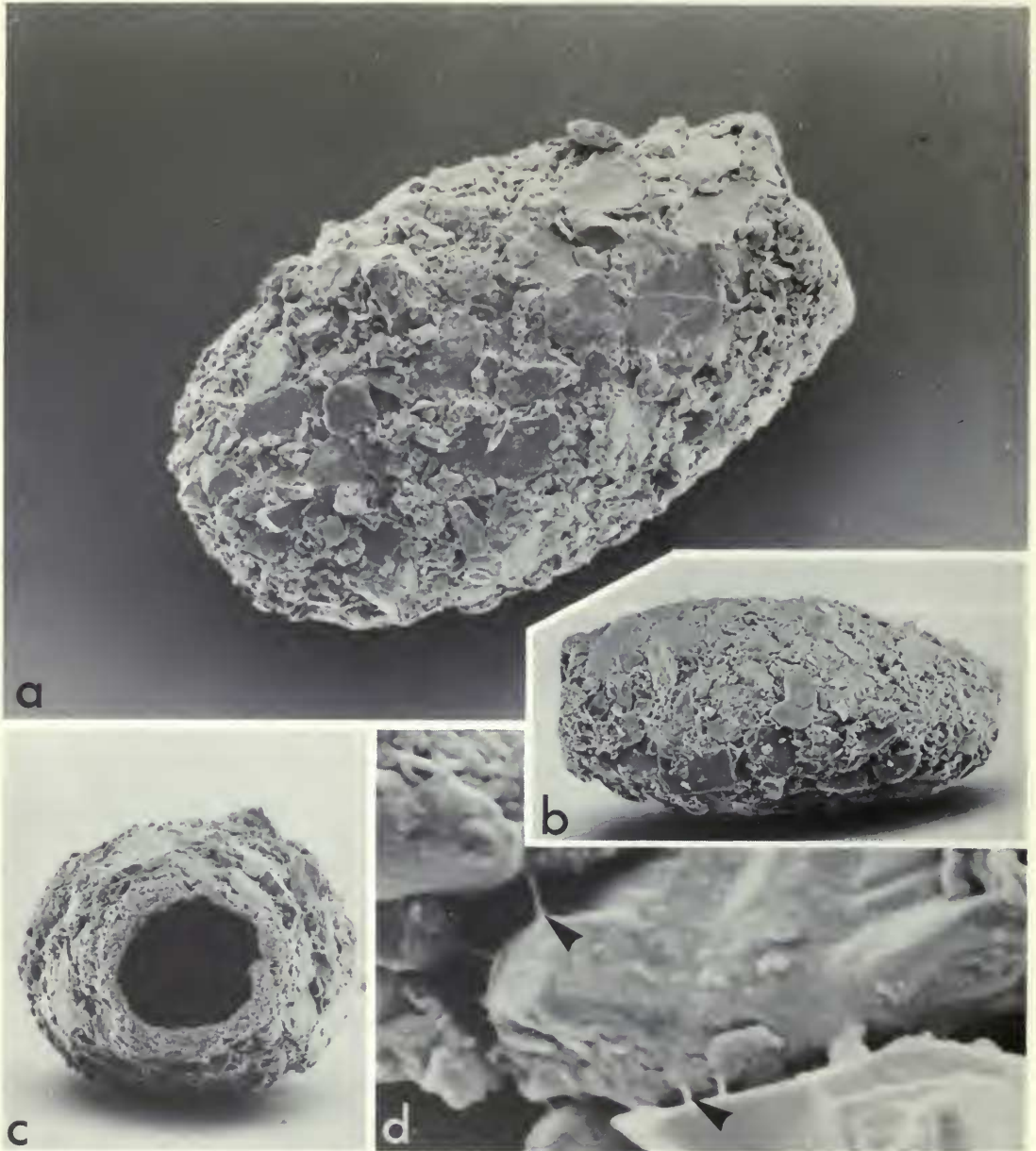


Fig. 16 *Diffflugia dragana* sp. nov.: a, lateral view to illustrate the general outline $\times 490$; b, view of lateral compression to show gradual curving at both extremities $\times 320$; c, apertural view $\times 400$; d, part of shell surface with strands of organic cement (arrowed) $\times 9400$.

REMARKS. This compressed specimen is similar to *D. lingula* Penard, 1911, *D. avellana* Penard, 1890 and *D. hiraethogii* Ogden, 1983. It differs from *D. lingula* and *D. avellana* which have pyriform shells, because of the narrow, elongate body which is almost cigar-shaped in lateral view (Fig. 16b), and wide aperture. Although it is most similar to *D. hiraethogii*, it lacks the distinct neck of this species and is again more elongate and not evenly compressed. *D. dragana* is considered to be distinct in having an elongate, compressed shell with a wide aperture.

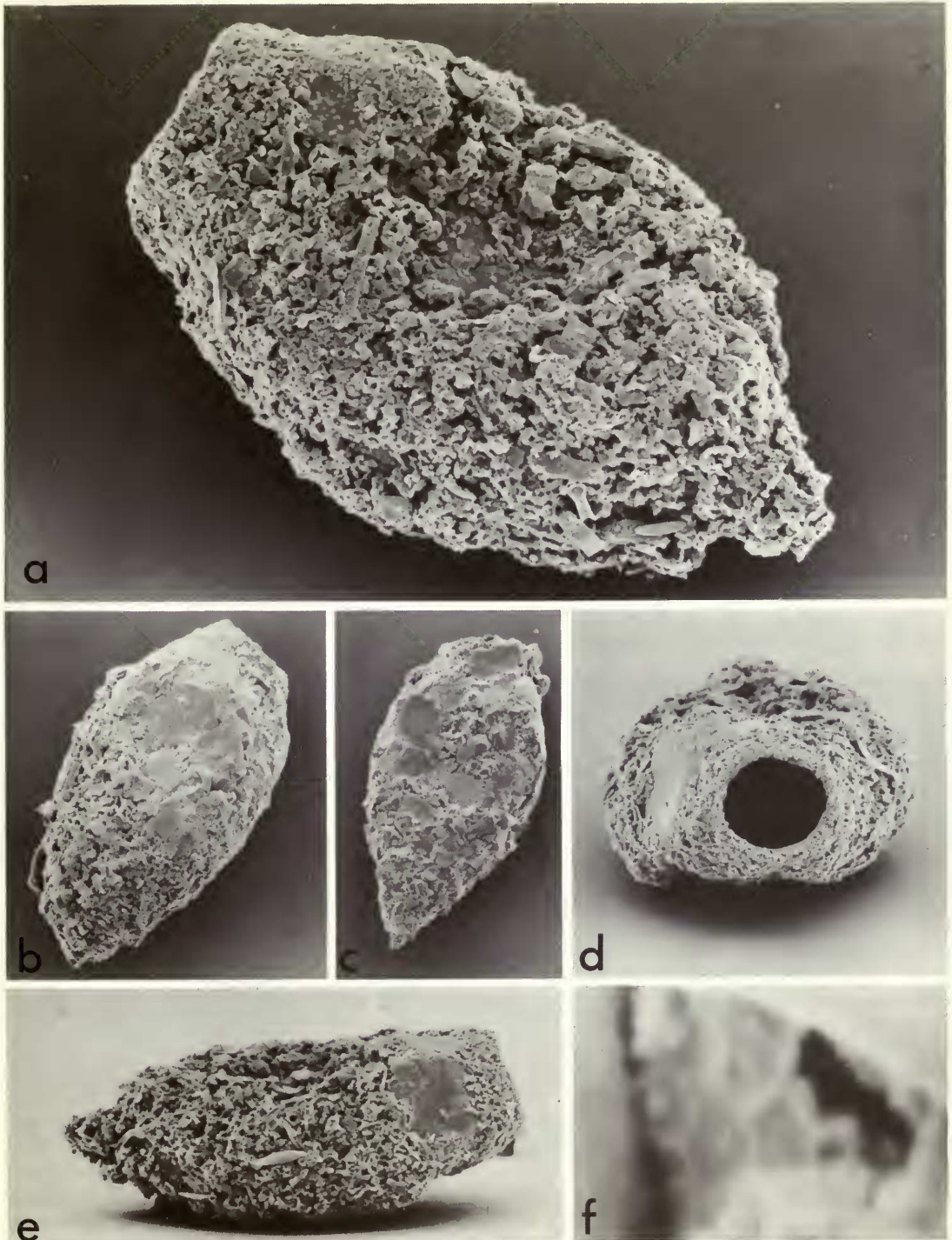


Fig. 17 *Diffflugia serbica* sp. nov.: a, lateral view of specimen encrusted with extraneous debris $\times 680$; b & c, additional specimens to illustrate the variations of tapering $\times 310$ & 240 ; d, apertural view $\times 420$; e, view to show lateral compression $\times 400$; f, detail of organic cement network $\times 21000$.

ETYMOLOGY. This species is named after Dragana Dorothea Živković, who has been most helpful in correcting the language shortcomings of both authors.

Diffugia serbica sp. nov.

DESCRIPTION. The shell is opaque, shaped like a spear-head, tapering evenly from the body to the pointed aboral extremity and gradually, anteriorly towards the short apertural collar, it is laterally compressed (Figs 17a–e). The body is composed mainly of medium to large flattish pieces of quartz with a mixture of small to medium pieces at the aperture and aboral extremity. Although the surface is usually smooth, two of the specimens are covered with a layer of small particular debris which appears to have been added after the shell was constructed (Fig. 17e). The organic cement is not frequently seen but is in the form of a network, the mesh being about 400 nm in diameter with walls 50 nm thick, each mesh being covered (Fig. 17f). The aperture is circular and usually surrounded by small particles (Fig. 17d).

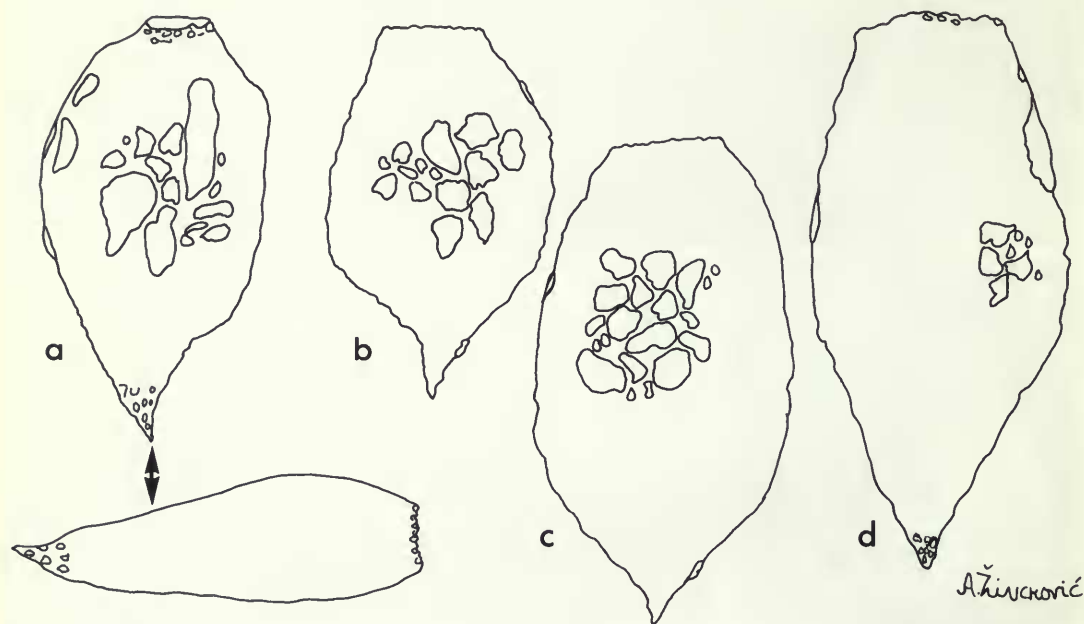


Fig. 18 *Diffugia serbica* sp. nov. Diagrams of four specimens to show the variation in outline.

MEASUREMENTS (in μm). Five specimens: body length 169–189, breadth 110–113, depth 68–79, diameter of aperture 31–41.

REMARKS. The dimensions of five specimens from the Yugoslavian sample were somewhat larger: body length 180–280, breadth 110–160, depth 75–115 (only two measured), diameter of aperture 40–70. Nevertheless, they demonstrate a similar variability in general shape and structure (Fig. 18). This species is similar to *D. soudanensis* Gauthier-Lièvre & Thomas (1958) and *D. kempyi* Stěpánek, 1953 in general dimensions, but both of these species have a distinct apertural collar, are curved aborally and have a median pronounced spine or horn. Furthermore, of these two species only *D. soudanensis* is compressed. *Diffugia serbica* is considered to be distinct in having an irregular spear-shaped shell which is laterally compressed, with the suggestion of a small apertural collar and usually pointed aborally.

Diffugia serrata sp. nov.

DESCRIPTION. The shell is transparent, ovoid, composed of small to medium flattish particles

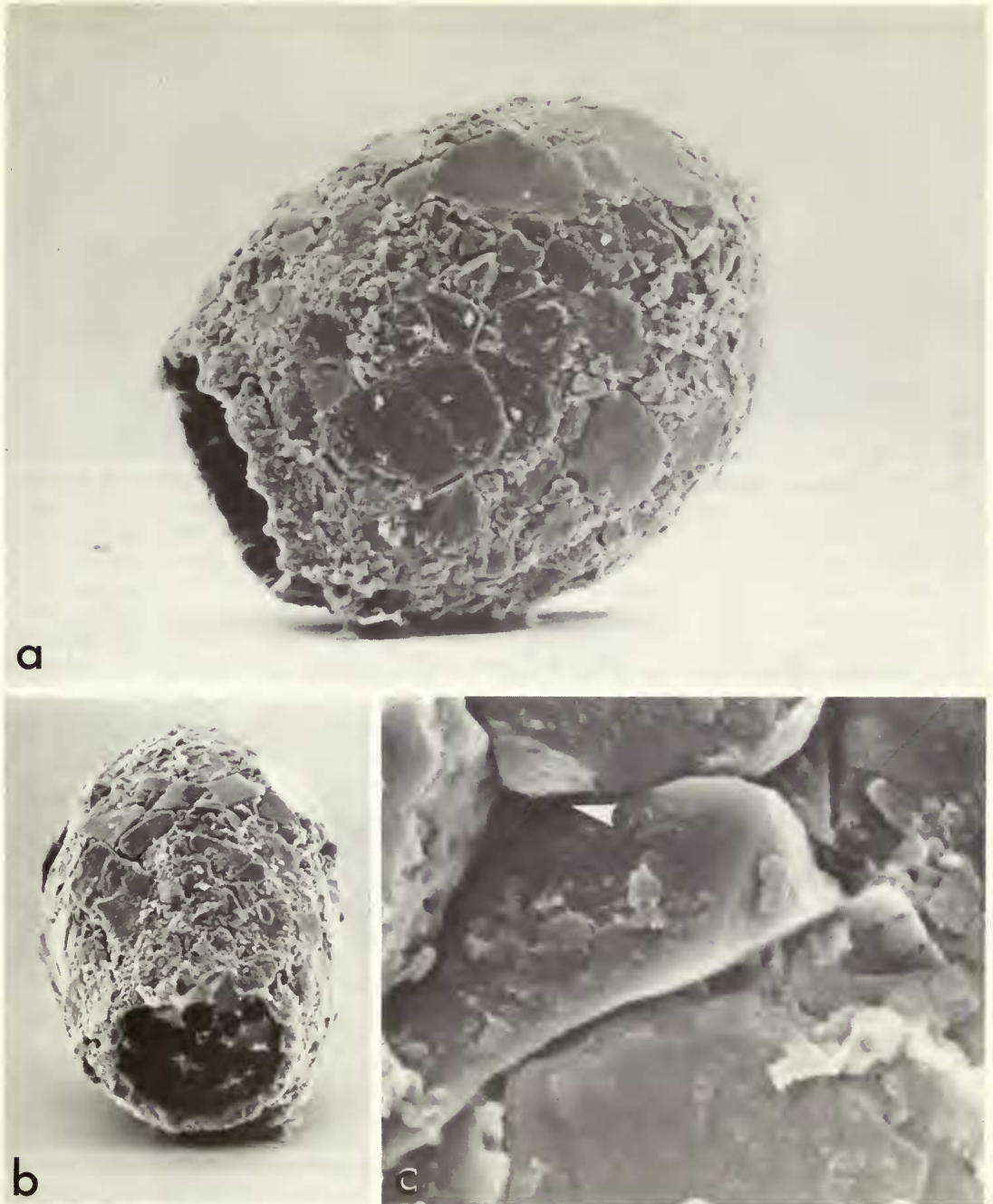


Fig. 19 *Diffflugia serrata* sp. nov.: a, lateral view, note the serrated apertural margin $\times 1300$; b, apertural view $\times 930$; c, portion of shell surface with organic cement (arrowed) $\times 9400$.

of quartz arranged to give a smooth surface (Fig. 19a). Organic cement is seen as small strands or as a smooth sheet, with regular perforations about 50 nm in diameter (Fig. 19c). The aperture is circular with a slight irregular or serrated margin (Figs 19a & b).

MEASUREMENTS (in μm). One specimen: body length 66, breadth 56, diameter of aperture 28.

REMARKS. This species is distinct from other ovoid species of similar dimensions, like *D.*

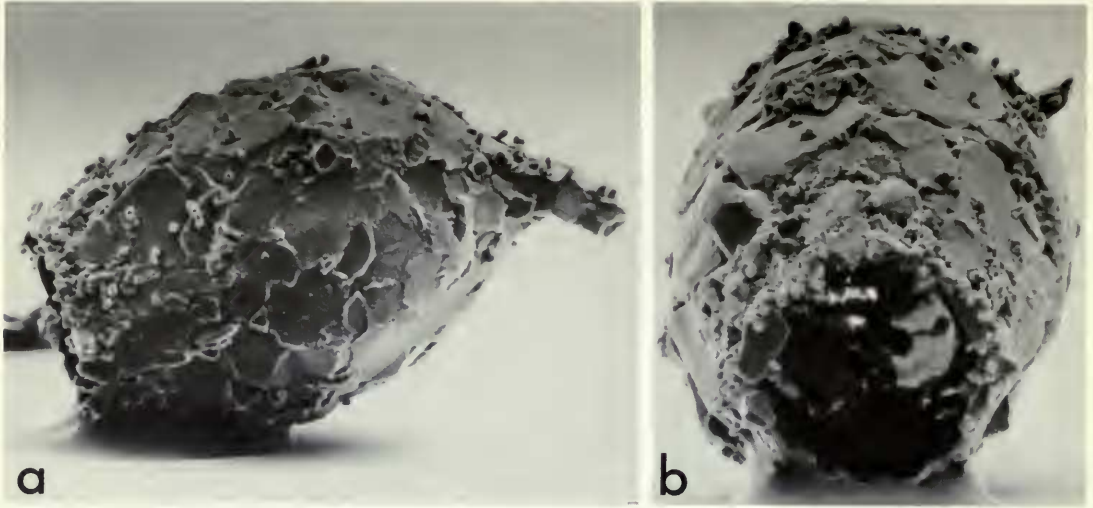
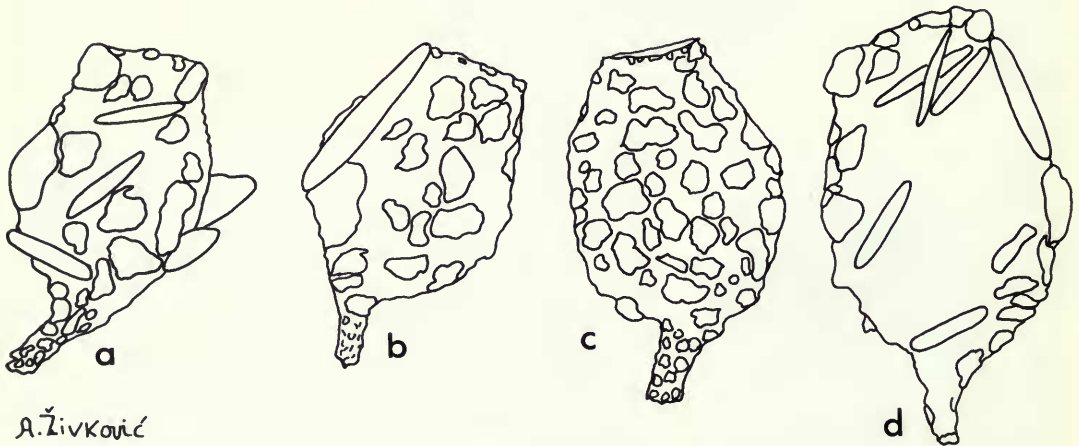


Fig. 20 *Difflugia styła* sp. nov.: a, lateral view to illustrate the aboral spine and smooth surface $\times 700$; b, apertural view $\times 960$.



A. Živković

Fig. 21 *Difflugia elegans*. Illustrations of four specimens, the typical constriction of the neck can be seen in a.

minuta Rampi, 1950 and *D. pristis* Penard, 1902 which have recently been redescribed by Ogden (1983), in having a thin smooth shell and a wide aperture. It is most similar to *D. pristis*, but the more ovoid or rounded shell, with a large and serrated aperture serve to distinguish *D. serrata*.

Difflugia styła sp. nov.

DESCRIPTION. The shell is transparent, ovoid with a distinct aboral spine (Fig. 20a). It is composed of small to medium flattish pieces of quartz, and a network of organic cement is often seen around the aperture as part of the shell matrix. Elsewhere on the surface the organic cement is seen as strands between particles. The aperture is circular and surrounded by smallish particles (Fig. 20b).

MEASUREMENTS (in μm). One specimen: body length 97, breadth 54, diameter of aperture 29.

REMARKS. This species is similar to *D. elegans* or *D. bicornis* (see p. 000) in having a single aboral spine or horn. However, both of these latter species are described as having a rough, irregular surface made of angular quartz particles and diatom frustules. In addition, *D. elegans* has a slight constriction of the neck which gives the aperture a flared appearance (Ogden, 1979), and it was found in the Yugoslavian portion of the sample to show these features (Fig. 21). Although *D. styla* shares similar dimensions to *D. serrata* (see p. 000) the presence of an aboral spine separates these species. *D. styla* is distinct in being elongate ovoid with an aboral spine, and having a smooth shell composed of flat particles.

Genus *CUCURBITELLA* Penard, 1902

Cucurbitella vlasinensis sp. nov.

DESCRIPTION. The shell is brown or opaque, subcircular or ovoid, with a distinct apertural collar (Fig. 22a). It is composed of a mixture of small to medium pieces of quartz to give a rough surface, but arranged so that the outline is more or less regular. The particles are packed close together (Fig. 22f), with only small areas of organic cement visible. The cement is in the form of a network whose mesh is covered by a smooth membrane (Fig. 22e). The collar is trilobed and composed of small pieces of quartz arranged randomly (Fig. 22b). A double thickness of particles strengthens the three tooth-like projections where they form a dividing barrier with the inner apertural opening; these 'teeth' are usually well defined and composed of small particles. Each lobe has a small recess or cavity so that the internal opening is smaller than the external collar, the floor of these recesses appears as a continuation of the shell matrix (Fig. 22d). The apertural opening is trilobed in sequence with the collar and lined with flattish pieces of quartz with smaller pieces filling the junctions (Fig. 22c).

MEASUREMENTS (in μm). Forty-one specimens: body length 81–113, breadth 69–97, diameter of collar 36–51, depth of collar 9–16, diameter of aperture 19–35.

REMARKS. In a review of the genus *Cucurbitella* by Gauthier-Lièvre & Thomas (1960) the number of lobes surrounding the aperture was used to differentiate species into a number of varieties and forms. More recently, Ogden (1980b) considered that the three and four lobed specimens of *C. mespiliformis* were otherwise identical in all but that feature, and should therefore be designated as a single species until adequate morphological information was available on the variability of lobe formation. Nevertheless, observations on the many specimens of the present sample show that there is little or no variation in the number and shape of the lobes. *C. vlasinensis* is similar to *C. modesta* Gauthier-Lièvre & Thomas, 1960 and *C. modesta* forma *trilobata* Gauthier-Lièvre & Thomas, 1960. It differs from *C. modesta*, which has four lobes, in that feature and general measurements, and from *C. modesta* forma *trilobata* in having well-defined teeth, a more extensive inner lining to each lobe and in overall larger general dimensions.

An interesting ecological point to note is that *C. modesta* forma *trilobata* was reported only from Morocco which has similar climatic conditions to the region of Yugoslavia where the present samples were collected.

ETYMOLOGY. This species is named after the location where the samples were collected, Lake Vlasina, and which, after a visit by both authors in 1982, has become especially significant.

Genus *PONTIGULASIA* Rhumbler, 1895

Pontigulasia bryophila Penard, 1902

DESCRIPTION. The shell is pyriform, tapering from the aperture to the slightly swollen posterior third of the body (Fig. 23a). It has a rough surface composed of a mixture of quartz particles with an occasional diatom frustule added. Organic cement is seen at the junctions

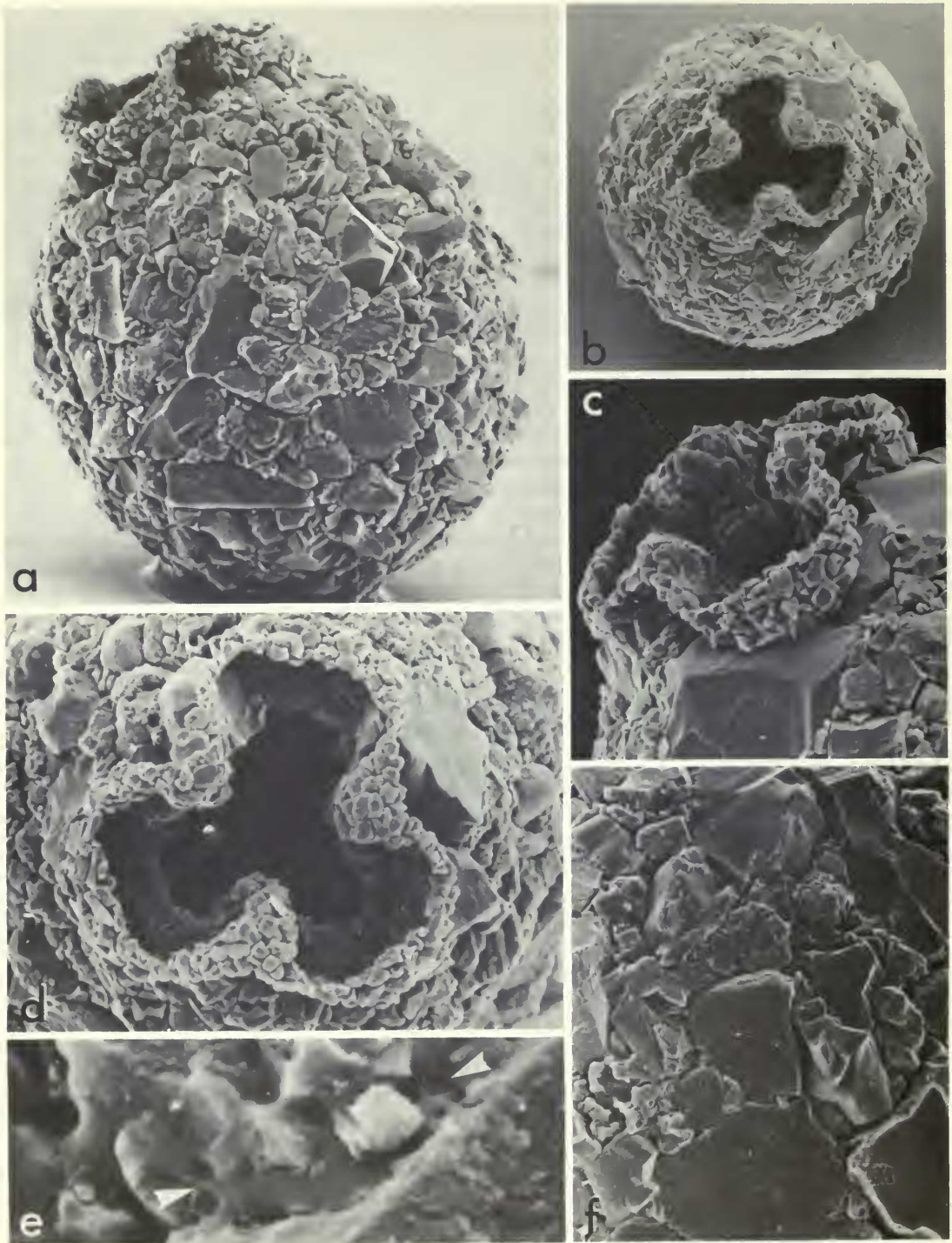


Fig. 22 *Cucurbitella vlasinensis* sp. nov.: a, lateral view $\times 830$; b, apertural view $\times 540$; c, view to illustrate the arrangement of particles around the collar $\times 1200$; d, detail of aperture to show tooth-like projections and smaller internal opening $\times 1200$; e, detail of organic cement (arrowed) $\times 13000$; f, portion of shell surface showing the close packing of particles $\times 1500$.

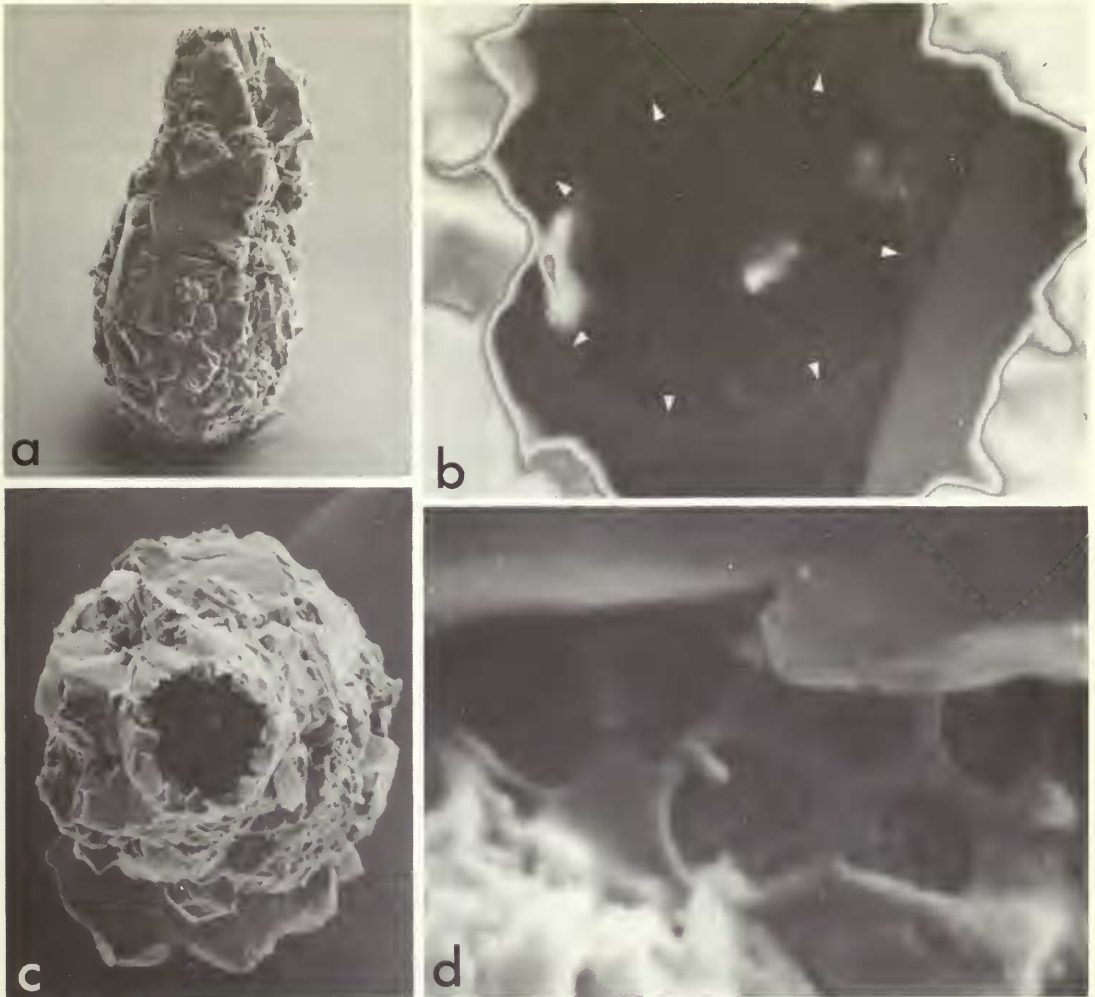


Fig. 23 *Pontigulasia bryophila*: a, lateral view $\times 470$; b, view inside external aperture to show the internal aperture opening (arrowed), micrograph obtained by 'expanded contrast' facility $\times 4100$; c, apertural view $\times 760$; d, detail of organic cement to illustrate the smaller irregular network of each mesh enclosure $\times 29000$.

between particles as a network. This network has a mesh about 600 nm in diameter separated by walls 200 nm thick. Each enclosure has a smaller irregular network over its surface (Fig. 23d). The external aperture is small, surrounded by small or medium particles often arranged to give a serrated or tooth-like margin (Fig. 23c). The single, internal aperture is roughly circular (Fig. 23b) and positioned about a quarter of the body length from the external aperture.

MEASUREMENTS (in μm). See Table 2.

REMARKS. This species is similar in general appearance to *Diffflugia bryophila* but may be distinguished from it by the presence of an internal aperture and a different organic cement pattern. The present specimens are similar in most respects to specimens of *P. bryophila* found in England (C.G.O. pers. observ.) except for a difference in organic cement patterns. This feature alone is not considered sufficient for specific recognition.

Pontigulasia montana sp. nov.

DESCRIPTION. The shell is pyriform, bluntly rounded aborally for one-third of its length and usually tapering gradually from the widest point towards the aperture (Fig. 24a), although sometimes there is a distinct constriction at the position of the internal aperture (Fig. 24c). It is composed of a mixture of mainly medium to large pieces of quartz arranged to give a rough surface. Organic cement is often seen as part of the shell matrix (Fig. 24d), in the form of an

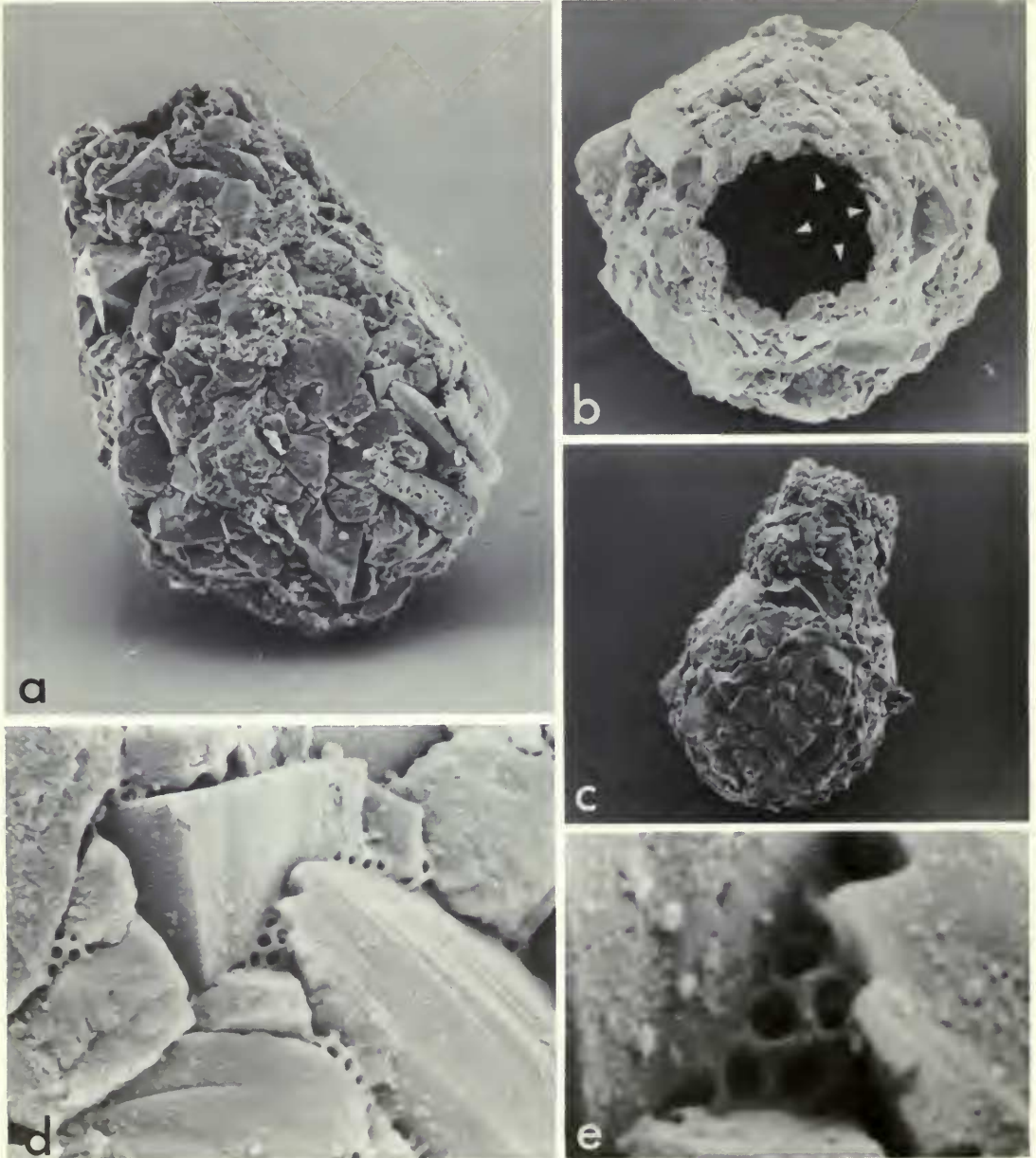


Fig. 24 *Pontigulasia montana* sp. nov.: a, lateral view of specimen without neck constriction $\times 730$; b, apertural view with the internal aperture arrowed $\times 730$; c, lateral view of specimen with distinct neck constriction $\times 430$; d, portion of shell surface showing organic cement as part of the shell matrix $\times 4400$; e, detail of organic cement network $\times 14000$.

open network with walls 200 nm thick and a mesh diameter of 400 nm (Fig. 24e). The external aperture is roughly circular and surrounded by small or medium particles randomly positioned to give it an irregular margin (Fig. 24b). The smaller, single, internal aperture is also circular and surrounded by small particles overlaid with organic cement.

MEASUREMENTS (in μm). See Table 3.

Table 3 Range of measurements (in μm) of two species of *Pontigulasia*

| | n | Length (l) | Breadth (B) | Diameter of external aperture (da) | Diameter of internal aperture | B/L | da/L |
|---------------------|---|---------------|----------------|--|-------------------------------------|-----------|-----------|
| <i>P. bryophila</i> | 4 | 99–146 | 52–66 | 18–21 | 11–14 | 0.52±0.05 | 0.15±0.03 |
| <i>P. montana</i> | 5 | 91–125 | 68–81 | 28–32 | 15–18 | 0.69±0.07 | 0.28±0.03 |

REMARKS. The specimens described here are similar to *Pontigulasia bryophila* Penard, 1902, but the latter species has a more streamlined, elongate shell, with smaller internal and external openings, plus a distinct organic cement pattern. Comparison of the measurements given in Table 3 emphasizes the difference in body and apertural size between these two species, furthermore, *P. bryophila* appears to be the only previously described species of *Pontigulasia* with a single internal aperture.

ETYMOLOGY. This species is named after the geographical topography surrounding Lake Vlasina, which is mountainous (*L. montana*).

Summary

The information provided by this study extends our knowledge of the family Diffugiidae, in particular the finding of compressed species of *Diffugia*. The scarcity of these forms is perhaps highlighted by the review of African species in which Gauthier-Lièvre & Thomas (1958) list twelve compressed species, of these nine were new, out of a total of one hundred and thirty-three. Thirty-three species of *Diffugia* are listed here of which thirteen are re-described, including two former varieties of *D. oblonga* — namely *D. lata* and *D. nodosa*, six new species are described — *D. balcanica*, *D. bistricea*, *D. dragana*, *D. serbica*, *D. serrata* and *D. styla* the first four having compressed shells. In addition, two other new species are described — *Cucurbitella vlasinensis* sp. nov. and *Pontigulasia montana* sp. nov.

It has been mentioned before (Ogden, 1980b) that the size and shape of the aperture in pyriform species of *Diffugia* is a relatively uniform character, but in ovoid specimens appears more variable as shown here in the description of *D. lismorensis*.

Morfološka studija nekih Diffugiidae iz Jugoslavije (Rhizopoda, Protozoa)

REZIME

Podatke date u ovom radu proširuju naša znanja o familiji Diffugiidae, naročito u pogledu otkrivanja pljosnatih vrsta *Diffugia*. Retkost ovih vrsta možda se najbolje ogleda u radu o afričkim vrstama, Gauthier-Lievre i Thomas (1958), u kome je dat spisak od ukupno 133 vrsta; među njima je dvanaest pljosnatih vrsta, od kojih je devet novih. Ovaj rad sadrži spisak od tridesettri vrste *Diffugia*, od kojih su trinaest ponovo opisane, uključujući i dva ranija varijeteta: *D. oblonga*, odnosno *D. lata* i *D. nodosa*, a opisano je i šest novih vrsta — *D. balcanica*, *D. bistricea*, *D. dragana*, *D. serbica*, *D. serrata* i *D. styla*, od kojih prve

četiri poseduju pljosnate ljuštore. Opisane su i dve nove vrste — *Cucurbitella vlasinensis* sp. nov. i *Pontigulasia montana* sp. nov.

U ranijim publikacijama ukazano je (Ogden, 1980b) da su veličina i oblik pseudostoma u piriformnim vrstama *Diffflugia* relativno konstantna, međutim, pojavljuje se veća varijabilnost u ovoidnim uzorcima, kao što je slučaj u *D. lismorensis*.

Proučeni materijal sakupljen je 9 septembra 1947. godine iz jedne bare sa prostrane sfagnumske tresave na Vlasini (1200 m) koja je izgradnjom akumulacionog jezera izčezla.

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